(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 November 2001 (08.11.2001)

PCT

(10) International Publication Number
WO 01/83701 A2

(51) International Patent Classification[7]: C12N

(21) International Application Number: PCT/US01/14394

(22) International Filing Date: 2 May 2001 (02.05.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/201,602 3 May 2000 (03.05.2000) US

(71) Applicant: **MONTEREY BAY AQUARIUM RESEARCH INSTITUTE** [US/US]; 7700 Sandholt Road, Moss Landing, CA 95039 (US).

(72) Inventors: **DELONG, Edward, F.**; 4 Blacktail Lane, Monterey, CA 93940 (US). **BEJA, Oded**; 408 Holovits Court, Marina, CA 93933 (US).

(74) Agent: **KAMINSKY, Rena**; Lumen Intellectual Property Services, Inc., 45 Cabot Avenue, Suite 110, Santa Clara, CA 95051 (US).

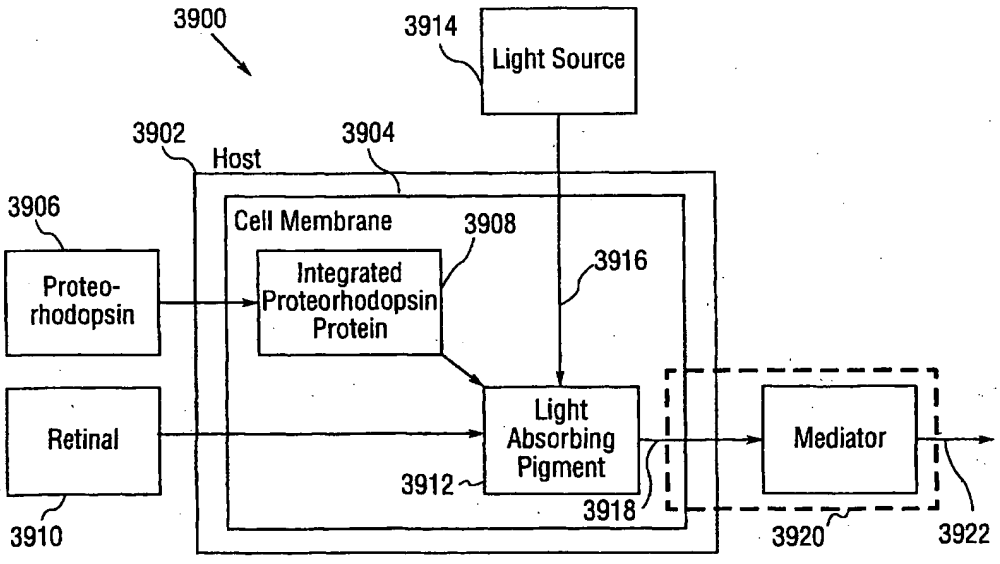
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CO, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *without international search report and to be republished upon receipt of that report*

*[Continued on next page]*

(54) Title: LIGHT-DRIVEN ENERGY GENERATION USING PROTEORHODOPSIN




(57) Abstract: A light-driven energy generation system using proteorhodopsin is provided. Proteorhodopsin sequences were retrieved and amplified from naturally occurring members of the domain Bacteria using proteorhodopsin-specific polymerase chain reaction primers. Proteorhodopsin sequences were placed in expression vectors for production of proteorhodopsin proteins in a host, for instance, *E. coli* and other bacteria. The system also includes a light source and a source of retinal, that allows the system to convert light into biochemical energy. The generated biochemical energy could be mediated into electrical energy by a mediator.

WO 01/83701 A2

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

PATENT APPLICATION

# LIGHT-DRIVEN ENERGY GENERATION USING PROTEORHODOPSIN

INVENTORS

**Edward F. DeLong and Oded Beja**

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is cross-referenced to and claims priority from U.S Provisional application 60/201,602 filed 05/03/2000, which is hereby incorporated by reference.

## STATEMENT REGARDING FEDERALLY SPONDORED RESEARCH OR DEVELOPMENT

This invention was supported in part by grant number OCE 0001619 from the National Science Foundation (NSF). The U.S. government has certain rights in the invention.

## STATEMENT TO COMPUTER DISK AND SEQUENCE LISTING

This application includes a sequence listing of 65 sequences and a computer disk labeled "Sequence Listing for application entitled "Light-driven energy generation using proteorhodopsin" by Edward F. DeLong and Oded Beja" containing files "MBA101-SEQLIST.prj", dated "04/23/01" with 174,089 bytes, which is the PatentIn

project file generated using PatentIn Version 3.0 software provided by the USPTO, and "MBA101-SEQLIST.txt", dated "04/23/01" with 323,739 bytes, which is the generated sequence listing from the PatentIn project file MBA101-SEQLIST.prj using PatentIn Version 3.0 software, all which are herein incorporated. The information recorded in computer readable format on the incorporated computer disk labeled "Sequence Listing" containing files "MBA101-SEQLIST.prj" and "MBA101-SEQLIST.txt" are identical to the incorporated written sequence listing.

## FIELD OF THE INVENTION

The present invention relates generally to gene expression of functional recombinant proteins in bacteria. More particularly, the present invention relates to proteorhodopsin genes and proteins that function as a light-driven energy generator in *Escherichia coli* (E. coli) and other bacteria.

## BACKGROUND ART

Retinal (vitamin A aldehyde) is a chromophore that binds integral membrane proteins (opsins) to form light-absorbing pigments called rhodopsins. Rhodopsins are currently known to belong to two distinct protein families. The visual rhodopsins, found in the eye throughout the animal kingdom, are photosensory pigments. Archeal rhodopsins, found in extreme halophilic environments, function as light-driven protons pumps (bacteriorhodopsins), chloride ion pumps (halorhodopsins), or photosensory receptors (sensory rhodopsins). The two protein families show no significant sequence similarity and may have different origins. They do, however, share identical topologies characterized by seven transmembrane α–helices that form a pocket in which retinal is covalently linked, as a pronated Schiff base (helix G).

The archaeal rhodopsins are able to generate a photocycle which produces a chemiosmotic membrane potential in response to light, as such light energy is converted into biochemical energy. Recently, a protein with high sequence similarity to the archaeal rhodopsins has also been retrieved in the eukaryote Neurospora crassa (*J.A. Bieszke et al., Proceedings of National Academy of Sciences USA 96:8034, 1999*). The eucaryal rhodopsin formed a photochemically reactive pigment when bound to all-trans retinal and exhibited photocycle kinetics similar to those of archaeal sensory rhodopsins (*J.A. Bieszke et al., Biochemistry 38:14138, 1999*). To date, however, no rhodopsin-like sequences have been reported in members of the domain Bacteria, and no light-driven proton pumps based on rhodopsin have ever before been functionally expressed in *E coli.*

The phototropic conversion of light energy into biochemical energy using bacteriorhodopsin can be harnessed for a variety of processes and applications, such as bio-electronic applications and bio-materials, as has been reported in US Patent No. 5,757,525 for optical devices, US Patent No. 5,854,710 for optical Fourier processing, and US Patent No. 5,470,690 for optical information storage. Bacteriorhodopsin in bio-electronic applications is aimed to interface, integrate, or substitute the silicon based microelectronics systems as well as molecular devices. Bacteriorhodopsin as a bio-material is integrated, for instance, in optical films for light mediated computer memory applications and pattern recognition.

Prevsiously, archaeal rhodopsins capable of generating a chemiosmotic membrane potential in response to light had only been found in halophilic archaea. Therefore, rhodopsins that originate from archaea adapted to highly saline environments cannot be functionally expressed in *E. coli.* Finally, the isolation and cultivation of

halorhodopsins is an elaborate process. At present one does not foresee an economic utilization possible for this process (e.g. US Patent 5,290,699).

Accordingly, as one skilled in the art might readily acknowledge, there is a strong need to retrieve and provide rhodopsin-like sequences from naturally occurring members of the domain Bacteria.

## OBJECTS AND ADVANTAGES

In light of the above, it is the primary objective of the present invention to provide rhodopsin-like sequences from naturally occurring members of the domain Bacteria. More specifically, it is the objective of the present invention to provide a method to retrieve proteorhodopsin genes from DNA of naturally occurring bacteria that encodes DNA sequence for proteorhodopsin proteins.

It is another objective of the present invention to provide proteorhodopsin-specific polymerase chain reaction primers that amplify the proteorhodopsin-containing gene from a DNA sample of naturally occurring bacteria.

It is yet another objective of the present invention to produce variants of a proteorhodopsin gene using the same proteorhodopsin-specific polymerase chain reaction primers by amplifying a proteorhodopsin-containing gene from of a mixed sample of naturally occurring bacteria.

It is still another objective of the present invention to provide an expression vector that produces a proteorhodopsin protein in *E. coli* and other bacteria.

It is another objective of the present invention to provide a light-driven energy generator in which the functional properties of proteorhodopsin are utilized. These properties include the ability to integrate within a host, for instance a cell membrane of *E. coli*, making an integrated proteorhodopsin protein, and the ability to bind retinal, making a light absorbing pigment.

It is another objective of the present invention to provide a light source and illuminate the light absorbing pigment to convert light energy into biochemical energy.

It is another objective of the present invention to provide a mediator and mediate the biochemical energy into electrical energy.

It is another objective of the present invention to provide methods to manipulate the kinetics of the light-driven energy generator.

The advantage of the present invention over the prior art is that it is not restricted to operate in halophilic archaea and could therefore be functionally expressed in *E. coli* and other bacteria. Accordingly, another advantage of the present invention is that it provides for a fast and cheap production method that allows for mass production of functionally active proteorhodopsin.

# SUMMARY

The present invention provides proteorhodopsin gene and protein sequences retrieved from samples of naturally occurring members of the domain Bacteria. More specifically, the present invention provides a method for the retrieval and amplification of proteorhodopsin genes from DNA samples of naturally occurring marine bacteria. In accordance with several exemplary embodiments of the present invention, DNA samples were obtained from naturally occurring bacteria such as, for instance, marine proteobacteria, SAR86 bacteria, or recombinant DNA libraries containing naturally occurring bacteria. The present invention provides proteorhodopsin-specific polymerase chain reaction (PCR) primers to amplify a proteorhodopsin gene from DNA samples of these marine bacteria. The present invention also provides a device and method for the placement of proteorhodopsin genes in an expression vector to produce functional proteorhodopsin proteins in *E. coli* and other bacteria.

Accordingly, the present invention provides a method to produce and obtain variants of proteorhodopsin genes and proteins. The same proteorhodopsin-specific polymerase chain reaction primers amplify different variants of proteorhodopsin-containing genes from a mixed sample of naturally occurring bacteria. As one skilled in the art might readily acknowledge, these variants of a proteorhodopsin gene produce functional variations in the photocycle kinetics of the proteorhodopsin protein.

Furthermore, the present invention provides a light-driven energy generator that utilizes proteorhodopsin to convert light-energy into biochemical energy. This light-driven energy generator takes advantage of the functional properties of the proteorhodopsin protein once expressed in, for example, *E. coli* or other bacteria as is

described in exemplary embodiments. These properties include the ability to integrate within a host such as, for instance, a cell membrane of *E. coli* or other Bacteria, and thereby making an integrated proteorhodopsin protein or integrated cell membrane protein. These properties also include the ability to bind retinal and thereby making a light absorbing pigment. Illuminating the light absorbing pigment with a light source converts light energy into biochemical energy. Finally, the biochemical energy can be mediated into electrical energy by a mediator.

In accordance with exemplary embodiments, the present invention enables one skilled in the art to manipulate the kinetics of the proteorhodopsin protein photocycle once it is operational in the light-driven energy generator. In particular, the present invention provides examples in which the light source characteristics are manipulated. Examples are the manipulation of the delivery of fast-light pulses and/or the delivery of light at different wavelengths. The present invention also provides examples in which incremental additions of retinal influences the function of the light-driven energy generator. In addition, a proteorhodopsin gene or protein variant can be selected to determine an absorption spectra of the light absorbing pigment to change the kinetics of the light energy generator, for instance to meet a design/functional criteria of an application wherein proteorhodopsin is utilized.

## BRIEF DESCRIPTION OF THE FIGURES

The objectives and advantages of the present invention will be understood by reading the following detailed description in conjunction with the drawings, in which:

**FIG. 1** illustrates the phylogenetic tree of bacterial 16S rRNA gene sequences including that encoded on the 130 kb bacterioplankton BAC clone (EBAC31A8).

**FIG. 2** provides a nucleotide sequence of polymerase chain reaction primer 1 (**Sequence ID No:2**) used to amplify a proteorhodopsin gene.

**FIG. 3** provides a nucleotide sequence of polymerase chain reaction primer 2 (**Sequence ID No:3**) used to amplify a proteorhodopsin gene.

**FIG. 4** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:4**) amplified from clone EBAC31A8 (**Sequence ID No:1**) using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence ID No:3**), and the deduced amino acid sequence (**Sequence ID No:5**) of the proteorhodopsin gene **Sequence ID No:4** amplified from clone EBAC31A8 (**Sequence ID No:1**).

**FIG. 5** provides a map of the secondary structure of the proteorhodopsin protein (**Sequence ID No:7**). Single letter amino acid codes are used (according to J. Sasaki and J.L. Spudich, Biophys. J. 75:2435, 1998). Predicted retinal binding pocket residues are marked in black.

**FIG. 6** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:8**) amplified from clone EBAC40E8 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:9**) of the proteorhodopsin gene **Sequence ID No:8** amplified from clone EBAC40E8.

**FIG. 7** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:10**) amplified from clone EBAC41B4 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:11**) of the proteorhodopsin gene **Sequence ID No:7** amplified from clone EBAC41B4.

**FIG. 8** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:12**) amplified from clone EBAC64A5 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:13**) of the proteorhodopsin gene **Sequence ID No:12** amplified from clone EBAC64A5.

**FIG. 9** provides a variants map of the DNA sequences of the proteorhodopsin gene with **Sequence ID No:4, Sequence ID No:8, Sequence ID No:10**, and **Sequence ID No:12** that were amplified from clone EBAC38A8, EBAC40E8, EBAC41B4 and EBAC64A5 respectively using the proteorhodopsin-specific PCR primer 1 (**Sequence ID No:2**) and 2 (**Sequence ID No:3**). Dots represent sequences having identical sequence as those in **Sequence ID No:4**.

**FIG. 10** provides a variant map of the deduced amino acid sequences encoded by the proteorhodopsin gene with **Sequence ID No:4, Sequence ID No:8, Sequence ID No:10**, and **Sequence ID No:12** that were amplified from respectively EBAC38A8, EBAC40E8, EBAC41B4 and EBAC64A5 using the proteorhodopsin-specific primer 1 (**Sequence ID No:2**) and 2 (**Sequence ID No:3**). Lower case represents the PCR primer sequence region. Dots represent residues having identical sequence as those in **Sequence ID No:5**.

**FIG. 11** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:14**) amplified from clone HOT0m1 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:15**) of the proteorhodopsin gene **Sequence ID No:14** amplified from clone HOT0m1.

**FIG. 12** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:16**) amplified from clone HOT75m1 using PCR primers 1 (**Sequence ID**

**No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:17**) of the proteorhodopsin gene **Sequence ID No:16** amplified from clone HOT75m1.

**FIG. 13** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:18**) amplified from clone HOT75m3 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:19**) of the proteorhodopsin gene **Sequence ID No:18** amplified from clone HOT75m3.

**FIG. 14** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:20**) amplified from clone HOT75m4 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:21**) of the proteorhodopsin gene **Sequence ID No:20** amplified from clone HOT75m4.

**FIG. 15** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:22**) amplified from clone HOT75m8 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:23**) of the proteorhodopsin gene **Sequence ID No:22** amplified from clone HOT75m8.

**FIG. 16** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:24**) amplified from clone MB0m1 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:25**) of the proteorhodopsin gene **Sequence ID No:24** amplified from clone MB0m1.

**FIG. 17** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:26**) amplified from clone MB0m2 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence

(**Sequence ID No:27**) of the proteorhodopsin gene **Sequence ID No:26** amplified from clone MB0m2.

**FIG. 18** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:28**) amplified from clone MB20m2 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:29**) of the proteorhodopsin gene **Sequence ID No:28** amplified from clone MB20m2.

**FIG. 19** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:30**) amplified from clone MB20m5 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:31**) of the proteorhodopsin gene **Sequence ID No:30** amplified from clone MB20m5.

**FIG. 20** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:32**) amplified from clone MB20m12 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:33**) of the proteorhodopsin gene **Sequence ID No:32** amplified from clone MB20m12.

**FIG. 21** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:34**) amplified from clone MB40m1 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:35**) of the proteorhodopsin gene **Sequence ID No:34** amplified from clone MB40m1.

**FIG. 22** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:36**) amplified from clone MB40m5 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence

(**Sequence ID No:37**) of the proteorhodopsin gene **Sequence ID No:36** amplified from clone MB40m5.

**FIG. 23** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:38**) amplified from clone MB40m12 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:39**) of the proteorhodopsin gene **Sequence ID No:38** amplified from clone MB40m12.

**FIG. 24** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:40**) amplified from clone MB100m5 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:41**) of the proteorhodopsin gene **Sequence ID No:40** amplified from clone MB100m5.

**FIG. 25** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:42**) amplified from clone MB100m7 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:43**) of the proteorhodopsin gene **Sequence ID No:42** amplified from clone MB100m7.

**FIG. 26** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:44**) amplified from clone MB100m9 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:45**) of the proteorhodopsin gene **Sequence ID No:44** amplified from clone MB100m9.

**FIG. 27** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:46**) amplified from clone MB100m10 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence

(**Sequence ID No:47**) of the proteorhodopsin gene **Sequence ID No:46** amplified from clone MB100m10.

**FIG. 28** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:48**) amplified from clone PALB1 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:49**) of the proteorhodopsin gene **Sequence ID No:48** amplified from clone PALB1.

**FIG. 29** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:50**) amplified from clone PALB2 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:51**) of the proteorhodopsin gene **Sequence ID No:50** amplified from clone PALB2.

**FIG. 30** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:52**) amplified from clone PALB5 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:53**) of the proteorhodopsin gene **Sequence ID No:52** amplified from clone PALB5.

**FIG. 31** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:54**) amplified from clone PALB7 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:55**) of the proteorhodopsin gene **Sequence ID No:54** amplified from clone PALB7.

**FIG. 32** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:56**) amplified from clone PALB6 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence

(**Sequence ID No:57**) of the proteorhodopsin gene **Sequence ID No:56** amplified from clone PALB6.

**FIG. 33** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:58**) amplified from clone PALB8 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:59**) of the proteorhodopsin gene **Sequence ID No:58** amplified from clone PALB8.

**FIG. 34** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:60**) amplified from clone PALE1 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:61**) of the proteorhodopsin gene **Sequence ID No:60** amplified from clone PALE1.

**FIG. 35** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:62**) amplified from clone PALE6 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:63**) of the proteorhodopsin gene **Sequence ID No:62** amplified from clone PALE6.

**FIG. 36** provides the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:64**) amplified from clone PALE7 using PCR primers 1 (**Sequence ID No:2**) and 2 (**Sequence No:3**), and the deduced amino acid sequence (**Sequence ID No:65**) of the proteorhodopsin gene **Sequence ID No:64** amplified from PALE7.

**FIG. 37** illustrates a phylogenetic tree of different proteorhodopsin genes.

**FIG. 38** provides an example of an alignment of proteorhodopsin amino acid sequences.

**FIG. 39** provides a light-driven energy generator that utilizes proteorhodopsin.

**FIG. 40** provides an example of a proteorhodopsin-expressing *E. coli* cell suspension (+) compared to control cells (-), both with all-*trans* retinal.

**FIG. 41** provides an example of absorption spectra of retinal-constituted proteorhodopsin in E coli membranes and a negative control.

**FIG. 42** provides an example of a light-driven transport of protons by a proteorhodopsin–expressing E. coli cell suspension.

**FIG. 43** provides an example of a transport of $[^3H]TPP^+$ in E. coli right-side-out vesicles containing expressed proteorhodopsin, reconstituted with or without 10 μM retinal in the presence of light or in the dark.

**FIG. 44** provides an example of laser flash-induced absorbance changes in suspensions of *E. coli* membranes containing proteorhodopsin.

**FIG. 45** provides an example of absorption spectra of retinal-constituted proteorhodopsin in *E. coli* membranes.

## DETAILED DESCRIPTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following preferred embodiment of the invention is set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

### Proteorhodopsin

The present invention provides rhodopsin-like gene and protein sequences retrieved from naturally occurring members of the domain Bacteria. More specifically, the

present invention provides a method for the retrieval and amplification of proteorhodopsin genes from DNA samples of naturally occurring marine bacteria. In accordance with exemplary embodiments of the present invention, DNA samples were obtained from naturally occurring marine bacteria such as bacteria from the SAR86 group. Provided as an exemplary embodiment of the SAR86 group, DNA samples were obtained from a bacterioplankton Bacterial Artificial Chromosome (BAC) clone BAC31A8 (also referred to as EBAC31A08). In general, as will be appreciated by those of ordinary skill in the art, suitable DNA samples can also be obtained from other sources, e.g., from a marine environment or from a recombinant DNA library containing genomic fragments of samples of naturally occurring bacteria.

**FIG. 1** shows the phylogenetic tree of bacterial 16S rRNA gene sequences including that encoded on the EBAC31A8. **FIG. 1** also shows the relationship of EBAC31A8 to the SAR86 bacteria group as well as to the gamma-proteobacteria group. A subclone shotgun library was constructed from BAC clone 31A8, and subclones were sequenced in both directions on the MegaBACE 1000 capillary array electrophoresis DNA sequencing instrument (Molecular Dynamics, Sunnyvale, CA). Sequence analysis of a 130-kb genomic DNA that encodes the ribosomal RNA operon from BAC31A8, reveals an open reading frame encoding a proteorhodopsin. In an exemplary embodiment, the contiguous sequence was assembled using SEQUENCHER 3.1.1 software (Gene Codes Co., Ann Arbor, MI). Other sequencing techniques can also be used, as will be recognized by those skilled in the art. The sequence of the proteorhodopsin-containing contig has been deposited in GenBank under accession #AF279106 and deposit date October 23rd, 2000. **Appendix A**, hereby incorporated, shows the nucleotide sequence of the BAC clone BAC31A8 (**Sequence ID No:1**)

which contains the 130 kilobases genomic DNA from a naturally occurring marine bacterium.

Proteorhodopsin was amplified from the 130 kilobase bacterioplankton BAC clone 31A8 (**Sequence ID No:1**) by polymerase chain reaction (PCR), using the proteorhodopsin-specific primers 5'-aCCATGGgtaaattattactgatattagg-3' (**Sequence ID No:2** and shown in **FIG. 2**) and 5'-agcattagaagattctttaacagc-3' (**Sequence ID No:3** and shown in **FIG. 3**). References for PCR are, for instance, *The Polymerase Chain Reaction,* Mullis et al., Ed. (Birkhauser, Boston, 1994) and U.S. Patent Nos. 4,683,195 and 4,683,202 to Mullis et al. The proteorhodopsin-specific PCR primers include the addition of 3 nucleotides that encoded one amino acid not found in the native gene sequence of clone BAC31A8 (**Sequence ID No:6**), in the second amino acid position which is a glycine located on the 2$^{nd}$ codon ("GGT"). Therefore, compare the second amino acid position in the **Sequence ID No:5** using PCR primers 1 and 2 with the native **Sequence ID no:7**. This addition of one non-native amino acid created a new restriction endonuclease site (NcoI site) not present in the native sequence. This allowed subcloning of the amplified fragment into the NcoI restriction site of an expression vector pBAD TOPO TA Cloning® Kit (Invitrogen, La Jolla, CA). The present invention is not limited to the use of this type of expression vector and other expression vectors could also be used.

**FIG. 4** shows the nucleotide sequence of the proteorhodopsin gene (**Sequence ID No:4**) that results from amplification of the proteorhodopsin-containing DNA in BAC31A8 using proteorhodopsin-specific PCR primers **Sequence ID No:2** and **Sequence No:3**. **FIG. 4** also shows the deduced amino acid sequences (**Sequence ID No:5**) encoded by the proteorhodopsin gene (**Sequence ID No:4**).

**FIG. 5** shows an exemplary embodiment of a secondary structure of proteorhodopsin after it has been folded in a cell membrane **510** and bonded with retinal **520**. **FIG. 5** shows the native proteorhodopsin gene (**Sequence ID No:6**) obtained from clone BAC31A8 and encodes a proteorhodopsin protein of 249 amino acids with a molecular weight of 27 kD (**Sequence ID No:7**). In **FIG. 5, 530** indicates seven transmembrane domains, a typical feature of the rhodopsin protein family, that aligned well with the corresponding helices of the archaeal rhodopsins. **FIG. 5** also shows the amino acid residues that form a retinal binding pocket indicated by **520**. Although the proteorhodopsin proteins shown in **FIGS. 4** and **5** both originate from BAC31A8, they differ with respect to the second amino acid position. The reason is that the proteorhodopsin-specific PCR primers that were used to amplify the proteorhodopsin gene from BAC31A8 (which resulted in proteorhodopsin protein as in **FIG. 4**; **Sequence ID No:5**) included the addition of 3 nucleotides. These 3 nucleotides encoded one amino acid not found in the native gene sequence (**Sequence ID No:6**), in the second amino acid position which is a glycine located on the 2$^{nd}$ codon ("GGT"). Proteorhodopsin protein (**Sequence ID No:7**) as shown in **FIG. 5** originates from the native gene sequence without the addition of the 3 nucleotides. As mentioned above, the addition of the 3 nucleotides created a new restriction endonuclease site (NcoI site) that was not present in the native sequence and thereby allowed the amplified fragment to be subcloned into the NcoI site of the expression vector.

In the exemplary embodiment presented above, PCR primers with **Sequence ID No:2** and **Sequence ID No:3** were used. In general, the present invention provides a method for designing different proteorhodopsin-specific PCR primers that are all capable of amplifying a proteorhodopsin gene from DNA samples of naturally occurring microbial populations by polymerase chain reaction. In designing these

primers one first needs to determine a DNA sequence of a proteorhodopsin gene. Then one can design oligodeoxynucleotide primers with a Watson-Crick base pair complementary to 5' and 3' ends of the proteorhodopsin gene.

## Variants of Proteorhodopsin

In the previous section, an exemplary embodiment is provided of a proteorhodopsin gene and protein. The present invention also provides the retrieval of genetic variations of proteorhodopsin from naturally occurring genetic variations in naturally occurring bacterial populations. These genetic variations in proteorhodopsin sequences result in functional variations in the proteorhodopsin proteins as is discussed below.

The present invention enables one skilled in the art to use the same proteorhodopsin-specific PCR primers as shown in **FIGS. 2** and **3** to successfully amplify different sequence variants from DNA originating from mixed naturally occurring bacterial populations when it is compared to for instance the proteorhodopsin gene as shown in **FIG. 4**. As mentioned above, different proteorhodopsin-specific PCR primers could be used to amplify genetic variants of proteorhodopsin.

**FIGS. 6-8** show exemplary embodiments of three different and unique variants of the proteorhodopsin gene that were retrieved from a recombinant DNA library of other naturally occurring bacteria (i.e. the bacterial artificial chromosome library (BAC)). In general, genetic variants could be obtained from different DNA libraries containing naturally occurring bacteria as well as from samples of naturally occurring bacteria. **FIG. 6** shows the variant of the proteorhodopsin gene sequence (**Sequence ID No:8**) that is amplified from the BAC clone 40 (BAC40E8) with the same proteorhodopsin-

specific PCR primers as provided in **Sequence ID No:2** and 3. Accordingly, **FIG. 6** also shows the deduced amino acid sequence (**Sequence ID No:9**) of the genetic variant of proteorhodopsin shown in **FIG. 6**. **FIG. 7** shows the variant of the proteorhodopsin gene sequence (**Sequence ID No:10**) that is amplified from the BAC clone 41 (BAC41B4) with the same proteorhodopsin-specific PCR primers as provided in **Sequence ID No:2** and 3. Accordingly, **FIG. 7** also shows the deduced amino acid sequence (**Sequence ID No:11**) of the genetic variant of proteorhodopsin shown in **FIG. 7**. **FIG. 8** shows the variant of the proteorhodopsin gene sequence (**Sequence ID No:12**) that is amplified from the BAC clone 64 (BAC64A5) with the same proteorhodopsin-specific PCR primers as provided in **Sequence ID No:2** and 3. Accordingly, **FIG. 8** also shows the deduced amino acid sequence (**Sequence ID No:13**) of the genetic variant of proteorhodopsin shown in **FIG. 8**.

**FIG. 9** provides a variants map of the nucleotide sequences of the proteorhodopsin gene **Sequence ID No:4, Sequence ID No:8, Sequence ID No:10**, and **Sequence ID No:12** amplified from respectively BAC31A8, BAC40E8, BAC41B4 and BAC64A5 using the proteorhodopsin-specific PCR primers **Sequence ID No:2** and **Sequence ID No:3**. In **FIG. 9** lower case letters represent the PCR primer sequence region. Dots represent residues having identical sequence as those in **Sequence ID No:4**. These proteorhodopsin gene sequences differ by as much as 31 nucleotides as is shown in **FIG. 10**. **FIG. 10** provides a variant map of the deduced amino acid sequences of the proteorhodopsin genes shown in **FIG. 9**.

Using the same proteorhodopsin-specific PCR primers, as for instance shown in **FIGS. 2** and 3, proteorhodopsin genes were also amplified from bacterioplankton extracts. As mentioned above, any proteorhodopsin-specific PCR primer can be used. These bacterioplankton extracts include those from the Monterey Bay (referred to as MB

clones), the Southern Ocean (Palmer Station, referred to as PAL clones), and waters of the central North Pacific Ocean (Hawaii Ocean Time series station, referred to as HOT clones).

**FIGS. 11-36** show exemplary embodiments of different and unique variants of proteorhodopsin that were retrieved from the MB clones, PAL clones, and HOT clones. **FIGS. 11-36** each show a variant of a proteorhodopsin gene sequence that is amplified with the same proteorhodopsin-specific PCR primers as provided in **Sequence ID No:2** and **Sequence ID No:3** from respectively clones HOT0m1, HOT75m1, HOT75m3, HOT75m4, HOT75m8, MB0m1, MB0m2, MB20m2, MB20m5, MB20m12, MB40m1, MB40m5, MB40m12, MB100m5, MB100m7, MB100m9, MB100m10, PALB1, PALB2, PALB5, PALB7, PALB6, PALB8, PALE1, PALE6 and PALE7. The proteorhodopsin gene sequences retrieved from clones HOT0m1, HOT75m1, HOT75m3, HOT75m4, HOT75m8, MB0m1, MB0m2, MB20m2, MB20m5, MB20m12, MB40m1, MB40m5, MB40m12, MB100m5, MB100m7, MB100m9, MB100m10, PALB1, PALB2, PALB5, PALB7, PALB6, PALB8, PALE1, PALE6 and PALE7, have respectively **Sequence ID Nos: 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62,** and **64**. Accordingly, **FIGS. 11-36** also show the deduced amino acid sequence of each genetic variant of proteorhodopsin. The deduced amino acid sequence encoded by the proteorhodopsin gene retrieved from clones HOT0m1, HOT75m1, HOT75m3, HOT75m4, HOT75m8, MB0m1, MB0m2, MB20m2, MB20m5, MB20m12, MB40m1, MB40m5, MB40m12, MB100m5, MB100m7, MB100m9, MB100m10, PALB1, PALB2, PALB5, PALB7, PALB6, PALB8, PALE1, PALE6 and PALE7, have respectively **Sequence ID Nos: 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63,** and **65**.

In an exemplary embodiment shown in **FIG. 37**, fifteen different variants of proteorhodopsin in the PCR generated MB gene library **3710** were detected, falling into three clusters. The MB gene library includes MB clones MB0m2, MB40m5, MB20m2, MB40m12, MB100m10, MB20m12, MB40m1, MB100m5, MB20m5, MB100m7, MB0m1, and MB100m9 as well as BAC clones BAC40E8, BAC31A8 and BAC64A5. **FIG. 37** is based on a phylogenetic analysis of the inferred amino acids of cloned proteorhodopsin genes. Evolutionary distances calculated from 220 positions were used to infer the tree topology by the neighbor joining method using the PaupSearch program of the Wisconsin Package version 10.0 (Genetics Computer Group (GCG), Madison Wisconsin). Other methods could also be used. The variants of the MB library share at least 97% identity over 248 amino acids, as shown in **FIG. 38**, and 93% identity at the DNA level. All the PCR amplified proteorhodopsin genes from Antarctic marine bacterioplankton (e.g. the PAL clones) were different from those of Monterey Bay (e.g. the MB clones) sharing 78% identity over 248 amino acids with the Monterey clade. The changes in amino acid sequences were not restricted to the hydrophilic loops, but spread over the entire protein including changes near the retinal binding domain **3830** as shown in **FIG. 38**, which are predicted retinal-binding residues. **FIG. 38** shows an example of a multiple alignment of proteorhodopsin amino acid sequences that were obtained from different clones **3820.** The secondary structure is derived from hydropathy plots (boxes **3810** shows trans-membrane helices).

## Light-driven energy generator

**FIG. 39** provides a light-driven energy generator **3900** that utilizes proteorhodopsin, as obtained from naturally occurring bacteria as described above, to convert light-energy into biochemical energy. Light-driven energy generator **3900** takes advantage of the

functional properties of the proteorhodopsin protein once expressed in, for instance, *E. coli* and other bacteria. These properties include the ability of proteorhodopsin **3906** to integrate within the cell membrane **3904** of, for instance, *E. coli* making an integrated proteorhodopsin protein **3908** (also called an integrated cell membrane protein). These properties also include the ability of proteorhodopsin **3906** to bind retinal **3910**, making a light absorbing pigment **3912**. The source of retinal **3910** is not limited to chromophore retinal but could also include chemical derivatives of retinal, such as 3-methyl-5-(1-pyryl)-2E,4E-pentadienal, 3,7-dimethyl-9-(1-pyryl)-2E,4E,6E,8E-nonatetraenal, all-trans-9-(4-azido-2,3,5,6-tetrafluorophenyl)-3,7-dimethyl-2,4,6,8,-nonatetraenal and 2,3-dehydro-4-oxoretinal. Illuminating light absorbing pigment **3912** with a light source **3914** results in a chemiosmotic gradient or proton pump in which light energy **3916** is converted into biochemical energy **3918**. The chemiosmotic gradient involves pumping of protons from the inside to the outside of cell membrane **3904**. When the protons return to the inside of cell membrane **3904** it produces biochemical energy **3918** via a proton translocating ATP-ase. Finally, the biochemical energy **3918** is harnessed by a mediator **3920** to produce energy **3922** for a particular process. For example, since proteorhodopsin functions as a light driven proton pump, it generates energy in the form of a proton motive force across the host cell membrane upon illumination. This light-driven proton motive force can be converted to many other forms of energy, one example above being the regeneration of adenosine triphosphate (ATP), via a proton-translocating ATPase. This coupling of the proton motive force generated by proteorhodopsin, for use by proton-translocating ATPases to synthesize ATP, could be accomplished both in living cells, as well as in artificially constructed membrane systems such as liposomes. Proteorhodopsin-based systems can convert light energy to a wide variety of useful mechanical, chemical, and electrical energy forms, for many industrial and technological applications. These

include, but are not limited to, use in targeted drug delivery, uses as primary or secondary energy generators for biocatalyic reactors, fuel cells and nano-machines (including molecular motors), as well as uses in molecular switching or data storage devices.

Applications that can potentially benefit from proteorhodopsin-light driven energy generation are, for instance, bio-electronics applications that are aimed to interface, integrate, or substitute the silicon based microelectronics systems as well as molecular devices. Other applications that can potentially benefit from proteorhodopsin-light driven energy generation are, for instance, in bio-materials, wherein proteorhodopsin is integrated as a bio-material in, for instance, optical films for light mediated computer memory applications, optical information storage and pattern recognition.

Alternatively, proteorhodopsin is useful for a process to enhance yield or increase the potential of recombinant protein production or converting the light induced membrane potential into cellular signals, including modulation of gene expression. The biochemical energy derived from functional proteorhodopsin exposed to light could be harnessed to support a variety of cellular processes. For instance, the energy derived from light-mediated proton pumping could be used to enhance the production of secondary metabolites, or recombinant proteins in host cells, such as *E. coli*. Often, production of specific compounds in the biotechnology industry is limited, since their optimal expression or production occurs in the late stationary phase of growth, when energy reserves of the host cells are low. Retinal-bound proteorhodopsin expressed in such cells would provide an ample source of biochemical energy, by simple illumination. Proteorhodopsin-mediated light driven proton production could enhance any variety of biosynthetic or physiological processes which require energy.

The biochemical energy derived from proteorhodopsin light driven proton pumping could also be converted to other generally useful energy forms, for example electricity. Microbial fuel cells currently use carbon-based compounds, such as glucose, as the primary energy source. Via specific mediators of reduction potential (e.g. electrons), these microbial fuel cells convert cellular biochemical energy to electrical potential. Unlike carbon-based microbial fuel cells, proteorhodopsin uses light as the energy source, that can then be converted into a chemiosmotic potential, and finally into cellular biochemical energy by membrane-bound proton ATP-ases. Therefore, the use of proteorhodopsin could be employed to derive energy from light as the primary or supplementary energy source, that could then be converted into electrical potential (analogous microbial fuel cells that derive their energy from glucose).

In addition to energy generation in vivo in living cells, membranes containing proteorhodopsin could be used to enhance or enable other specific processes in vitro. Polymers produced from proteorhodopsin-containing membranes may have specific properties that could be used similarly to those containing bacteriorhodopsin. One example includes the use of these light sensitive molecules for optical computing applications.

As shown in **FIG. 39**, the kinetics of proteorhodopsin as it is utilized in **3900** is influenced by various factors such as the type of light source **3914** and the manipulation of light source **3914** in terms of frequency and/or wavelength at which the light **3916** is delivered. Light source **3914** could be any type of light source that delivers light energy **3916** that would be absorbed by light absorbing pigment **3918**.

For example, the light source **3914** could be tuned to optimally excite rhodopsin variances with an absorbance maximum of 490 nm or alternatively those rhodopsins with an absorbance maximum of 520 nm. Manipulation of the light source **3914** or the light **3916** being emitted by the light source **3914,** for example, involves changing the frequency of fast-light pulses or the delivery of light **3916** as individual pulses, a train of pulses, or a continuous source of light. Manipulation also involves changing the wavelength of the delivery of light **3916** at different wavelengths. In addition, as is clear for one skilled in the art, changing the frequency and/or amount of retinal that will bind within integrated cell membrane protein **3908** also varies the function of proteorhodopsin. Finally, as was mentioned in the previous section, genetic variants of proteorhodopsin result in variants of the proteorhodopsin proteins that changes the kinetics of **3600** due to a difference in absorption of light at different wavelengths. The functional expression of such variation in these proteorhodopsin proteins adds another source of variation to the kinetics of proteorhodopsin as it is utilized in **3900.**

As shown in **FIG. 39**, the light-driven energy generator includes a host **3902.** In the present invention, as a preferred embodiment, host **3902** is a cell membrane preparation of *E. coli.* However, the present invention is not limited to the use of *E. coli* and, alternatively, other bacteria or eukaryotes could be used to provide host **3902** as an intact cell (in vivo) and/or as a cell membrane preparation (in vitro). For example, but not limited to, bacteria and yeast with developed genetic systems such as Bacillus spp. Species, Saccharomyces spp., Streptomyces spp. or Pichia spp. could be used as host for the expression of proteorhodopsin. In addition, in case a cell membrane preparation (in vitro) is used, host **3902** becomes equivalent to cell membrane **3904.**

The light-driven energy generator **3900**, as shown in **FIG. 39**, further includes proteorhodopsin **3906**. Proteorhodopsin is presented in the form of the earlier presented expression vector containing a proteorhodopsin gene or one of its variants. Once proteorhodopsin **3906** has been put into host **3902**, the proteorhodopsin expression vector expresses the proteorhodopsin protein in host **3902**. An integral cell membrane protein **3908** is created in which the proteorhodopsin protein inserts into and folds properly within the cell membrane **3904**. This is accomplished in the *E. coli* host by virtue of the native signal sequence found in the 5' end of the proteorhodopsin gene. It could also be accomplished by replacement of native sequence with another host-specific signal sequence in non-*E. coli* host systems.

As shown in **FIG. 39**, once retinal **3910** is added to cell membrane **3904**, retinal **3910** binds within integrated cell membrane protein **3908** and forms a light absorbing pigment **3912**. The particular example of **FIG. 40** shows an integrated proteorhodopsin protein **3908** bound to retinal **3910** in *E. coli*. Chemical derivatives of retinal (as discussed above) could also be used as a substitute chromophore to generate functional proteorhodopsin. For the particular example of **FIG. 40**, the proteorhodopsin protein was cloned with its native signal sequence and included an addition of the V5 epitope, and a polyhistidine tail in the C-terminus. The proteorhodopsin protein was expressed in host **3902**, i.e. *E. coli* outer-membrane protease-deficient strain UT5600, and induced with 0.2 % arabinose for 3 hours. Cell membranes **3904** were prepared and resuspended in 50 mM Tris-Cl (pH 8.0) and 5 mM $MgCl_2$. **FIG. 40** shows a proteorhodopsin-expressing *E.coli* cell suspension. After 3 hours of induction in the presence of 10 μM all-trans retinal, cells expressing the protein acquire a reddish pigmentation as indicated by **4010** and the + (plus) symbol. **FIG. 40** also shows that a cell suspension using the same PCR primers

(**Sequence ID No:2** and **3**) but now in opposite orientation as a negative control, did not acquire a reddish pigmentation as indicated by **4020** and the – (minus) symbol.

**FIG. 41** shows an exemplary embodiment of the absorption spectra of light absorbing pigment **3912** upon illumination with light source **3914** as is shown in **FIG 39**. As mentioned above, the light absorbing pigment is a retinal-reconstituted proteorhodopsin in *E. coli*. **FIG. 41** shows absorption spectra of light absorbing pigment **3912** as well as a negative control. After retinal **3910** addition to integrated proteorhodopsin protein **3908**, light absorbing pigment **3912** was made. The retinal **3910** addition was done at selected time points, i.e. 10, 20, 30 and 40 min, and shows a progression from low to high absorption values indicated by respectively **4110**, **4120**, **4130** and **4140** upon illumination with light source **3914**. **FIG. 41** also shows the absorption spectra of retinal **3910** addition at these similar time points but now to a negative control of retinal **3910** containing a proteorhodopsin **3906** that was created using the same PCR primers in opposite orientation. **4150**, **4160**, **4170** and **4180** indicate the four absorption spectra for the negative control. An absorption peak at 520 nm was observed after 10 minutes (**4110**) of incubation as illustrated in **FIG. 41**. On further addition of retinal, the peak at 520 nm increased, and had a ~100 nm half bandwidth. The 520 nm absorption peak was generated only in membranes containing proteorhodopsin **3906**, and only in the presence of retinal **3910**. The red shifted λmax of retinal (λmax = 370 nm in the free state) is indicative of a protonated Shiff base covalent linkage of retinal to proteorhodopsin.

**FIG. 42** shows an exemplary embodiment of the light mediated proton pump of the light-driven energy generator **3900** indicating the conversion of light energy **3916** as shown in **FIG. 39**. The proton pump action is illustrated by measuring pH changes in

the medium surrounding the host **3902**, which in this particular example involves a cell suspension of *E. coli*, illuminated by light source **3914**. The beginning and cessation of illumination (with yellow light >485 nm delivered by **3916**) is indicated **4110** ("ON") and **4120** ("OFF") respectively. The cells were suspended in 10 mM NaCl, 10 mM $MgSO_4 \cdot 7H_2O$ and 100 μM $CaCl_2$. Net outward transport of protons was observed solely in proteorhodopsin-containing *E. coli* cells, and only in the presence of retinal **3910** and light **3916** and is indicated by **4210** in **FIG. 42**. Light-induced acidification of the medium was completely abolished by the presence of 10 μM of the protonophore CCCP.

**FIG. 43** is an exemplary embodiment showing that illumination by light source **3914** generates an electrical potential at the membrane **3904** in proteorhodopsin-containing right-side-out membrane vesicles, in the presence of retinal **3910**, reaching –90 mV after 2 minutes from light **3916** onset. Transport of $[^3H]TPP^+$ in *E. coli* right-side-out vesicles containing expressed proteorhodopsin, reconstituted with (**4310** and **4320**) or without (**4330** and **4340**) 10 μM retinal **3910** in the presence of light (**4310** and **4330**) delivered by the light source **3914** or in the dark (**4320** and **4340**). **FIG. 43** shows that proteorhodopsin, in its form of **3912** as a light absorbing pigment, pumps protons from the inside to the outside of cell membrane in a physiologically relevant range. The ability of proteorhodopsin to generate a physiologically significant membrane potential, even when heterologously expressed in nonnative membranes, is consistent with the proton pumping function for proteorhodopsin in the native gamma proteobacteria from which it is derived.

**FIG. 44** is an exemplary embodiment showing that proteorhodopsin can have a fast photocycle and can therefore be characterized as a fast and therefore efficient

transporter of protons. For the particular example of **FIG. 44**, light absorbing pigment **3912** is induced by laser pulses delivered by light source **3914**. Laser pulse-induced absorption changes are shown by **3912** in host **3902**, which in this case are suspensions of *E. coli* membranes containing proteorhodopsin. A 532-nm pulse (6 ns duration, 40 mJ) was delivered at time 0 and absorption changes were monitored at various wavelengths in the visible range in a lab-constructed pulse photolysis system. 64 transients were collected for each wavelength. **4410** indicates transients at 3 wavelengths exhibiting maximal amplitudes. **4420** indicates absorption difference absorption spectra calculated from amplitudes at 0.5 ms (indicated by **4430**) and between 0.5 ms and 5.0 ms (indicated by **4440**). In **4410**, transient depletion occurred near the absorption maximum of pigment **3912** (500-nm trace indicated by **4450**), and transient absorption increase was detected at 400 nm (indicated by **4460**) and 590 nm (indicated by **4470**), indicating a functional photocyclic reaction pathway. In **4420**, the absorption difference spectrum shows that within 0.5 ms an intermediate with maximal absorption near 400 nm is produced (indicated by **4430**), typical of unprotonated Schiff base forms (M intermediates) of retinylidene pigments. The 5-ms minus 0.5-ms difference spectrum **4440** shows that following M decay an intermediate species red-shifted from the unphotolyzed 520-nm state appears. The decay of proteorhodopsin final intermediate is the rate limiting step in the photocycle and is fit well by a single exponential process of 15 ms, with an upward baseline shift of 13% of the initial amplitude.

As mentioned above, a proteorhodopsin gene or protein variant can be selected to determine an absorption spectra of the light absorbing pigment to change the kinetics of the light energy generator **3900**, for instance to meet a design/functional criteria of an application wherein proteorhodopsin is utilized. **FIG. 45** shows an exemplary

embodiment of different absorption spectra of retinal-reconstituted proteorhodopsins in *E. coli* as a function of wavelength **4510**. As shown in **FIG. 45**, the absorbance **4520** is different and depends on the clone from which the proteorhodopsin was amplified. In this particular example, 5 μm all-*trans* retinal was added to the membranes suspensions in a 100 mM phosphate buffer, with a pH 7.0, and absorption spectra were recorded. The four spectra **4530, 4540, 4550,** and **4560** are respectively for the proteorhodopsin genes retrieved from clones HOT75m4, PALE6, HOT0m1, and BAC31A8 at 1 hour after retinal addition. The proteorhodopsin gene retrieved from clone HOT75m4 **4530** and PALE6 **4540** produced a blue (490 nm) absorption maximum. The proteorhodopsin gene retrieved from clone HOT0m1 **4550** and BAC31A8 **4560** produced a green (527 nm) absorption maximum. In general, a range of wavelengths could be obtained that is not limited to the range shown in the example of **FIG. 45.**

It will be clear to one skilled in the art that the above embodiment may be altered in many ways without departing from the scope of the invention, such as for instance by mutagenesis to change the genetic sequence of proteorhodopsin and thereby changing the kinetics of the proteorhodopsin protein once it is expressed. Accordingly, the following claims and their legal equivalents should determine the scope of the invention.

# DEPOSITS

Depository address: 10801 University Boulevard, Manassas, VA 20110, USA.

The Escherichia coli containing cloned DNA BAC 31A8 having assigned ATCC number PTA-3083, the Escherichia coli containing cloned DNA BAC 40E8 having assigned ATCC number PTA-3082, the Escherichia coli containing cloned DNA BAC 41B4 having assigned ATCC number PTA-3080, and the Escherichia coli containing cloned DNA BAC 64A5 having assigned ATCC number PTA-3081, all having been deposited on February 21, 2001 with the ATCC Patent Depository.

The Escherichia coli containing a plasmid PAL E6 having assigned ATCC number PTA-3250, the Escherichia coli containing a plasmid HOT 0m1 having assigned ATCC number PTA-3251, the Escherichia coli containing a plasmid HOT 75m4 having assigned ATCC number PTA-3252, and the Escherichia coli containing cloned DNA BAC64A5 having assigned ATCC number PTA 3082, all having been deposited on March 30, 2001 with the ATCC Patent Depository.

# LIGHT-DRIVEN ENERGY GENERATION USING PROTEORHODOPSIN

## LIST OF SEQUENCES THAT ARE LISTED IN THE INCORPORATED SEQUENCE LISTING

**Sequence ID No:1** bacterial artificial chromosome (BAC) clone 31A8 (EBAC31A8).

**Sequence ID No:2** nucleotide sequence of proteorhodopsin-specific polymerase chain reaction (PCR) primer 1.

**Sequence ID No:3** nucleotide sequence of proteorhodopsin-specific polymerase chain reaction (PCR) primer 2.

**Sequence ID No:4** nucleotide sequence of the proteorhodopsin gene amplified from clone EBAC31A8 (Sequence ID No. 1) using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:5** deduced amino acid sequences of the proteorhodopsin gene amplified from clone EBAC31A8 (Sequence ID NO:4).

**Sequence ID No:6** native proteorhodopsin nucleotide sequence from clone EBAC31A8 (Sequence ID No:1).

**Sequence ID No:7** deduced amino acid sequences of the native proteorhodopsin nucleotide sequence from clone EBAC31A8 (Sequence ID No:6).

**Sequence ID No:8** nucleotide sequence of the proteorhodopsin gene amplified from clone EBAC40E8 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:9** deduced amino acid sequences of the proteorhodopsin gene amplified from clone EBAC40E8 (Sequence ID NO:8).

**Sequence ID No:10** nucleotide sequence of the proteorhodopsin gene amplified from clone EBAC41B4 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:11** deduced amino acid sequences of the proteorhodopsin gene amplified from clone EBAC41B4 (Sequence ID NO:10).

**Sequence ID No:12** nucleotide sequence of the proteorhodopsin gene amplified from clone EBAC64A5 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:13** deduced amino acid sequences of the proteorhodopsin gene amplified from clone EBAC64A5 (Sequence ID NO:12).

**Sequence ID No:14** nucleotide sequence of the proteorhodopsin gene amplified from clone HOT0m1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:15** deduced amino acid sequences of the proteorhodopsin gene amplified from clone HOT0m1 (Sequence ID NO:14).

**Sequence ID No:16** nucleotide sequence of the proteorhodopsin gene amplified from clone HOT75m1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:17** deduced amino acid sequences of the proteorhodopsin gene amplified from clone HOT75m1 (Sequence ID NO:16).

**Sequence ID No:18** nucleotide sequence of the proteorhodopsin gene amplified from clone HOT75m3 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:19** deduced amino acid sequences of the proteorhodopsin gene amplified from clone HOT75m3 (Sequence ID NO:18).

**Sequence ID No:20** nucleotide sequence of the proteorhodopsin gene amplified from clone HOT75m4 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:21** deduced amino acid sequences of the proteorhodopsin gene amplified from clone HOT75m4 (Sequence ID NO:20).

**Sequence ID No:22** nucleotide sequence of the proteorhodopsin gene amplified from clone HOT75m8 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:23** deduced amino acid sequences of the proteorhodopsin gene amplified from clone HOT75m8 (Sequence ID NO:22).

**Sequence ID No:24** nucleotide sequence of the proteorhodopsin gene amplified from clone MB0m1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:25** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB0m1 (Sequence ID NO:24).

**Sequence ID No:26** nucleotide sequence of the proteorhodopsin gene amplified from clone MB0m2 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:27** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB0m2 (Sequence ID NO:26).

**Sequence ID No:28** nucleotide sequence of the proteorhodopsin gene amplified from clone MB20m2 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:29** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB20m2 (Sequence ID NO:28).

**Sequence ID No:30** nucleotide sequence of the proteorhodopsin gene amplified from clone MB20m5 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:31** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB20m5 (Sequence ID NO:30).

**Sequence ID No:32** nucleotide sequence of the proteorhodopsin gene amplified from clone MB20m12 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:33** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB20m12 (Sequence ID NO:32).

**Sequence ID No:34** nucleotide sequence of the proteorhodopsin gene amplified from clone MB40m1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:35** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB40m1 (Sequence ID NO:34).

**Sequence ID No:36** nucleotide sequence of the proteorhodopsin gene amplified from clone MB40m5 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:37** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB40m5 (Sequence ID NO:36).

**Sequence ID No:38** nucleotide sequence of the proteorhodopsin gene amplified from clone MB40m12 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:39** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB40m12 (Sequence ID NO:38).

**Sequence ID No:40** nucleotide sequence of the proteorhodopsin gene amplified from clone MB100m5 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:41** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB100m5 (Sequence ID NO:40).

**Sequence ID No:42** nucleotide sequence of the proteorhodopsin gene amplified from clone MB100m7 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:43** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB100m7 (Sequence ID NO:42).

**Sequence ID No:44** nucleotide sequence of the proteorhodopsin gene amplified from clone MB100m9 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:45** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB100m9 (Sequence ID NO:44).

**Sequence ID No:46** nucleotide sequence of the proteorhodopsin gene amplified from clone MB100m10 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:47** deduced amino acid sequences of the proteorhodopsin gene amplified from clone MB100m10 (Sequence ID NO:46).

**Sequence ID No:48** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:49** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB1 (Sequence ID NO:48).

**Sequence ID No:50** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB2 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:51** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB2 (Sequence ID NO:50).

**Sequence ID No:52** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB5 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:53** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB5 (Sequence ID NO:52).

**Sequence ID No:54** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB7 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:55** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB7 (Sequence ID NO:54).

**Sequence ID No:56** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB6 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:57** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB6 (Sequence ID NO:56).

**Sequence ID No:58** nucleotide sequence of the proteorhodopsin gene amplified from clone PALB8 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:59** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALB8 (Sequence ID NO:58).

**Sequence ID No:60** nucleotide sequence of the proteorhodopsin gene amplified from clone PALE1 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:61** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALE1 (Sequence ID NO:60).

**Sequence ID No:62** nucleotide sequence of the proteorhodopsin gene amplified from clone PALE6 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:63** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALE6 (Sequence ID NO:62).

**Sequence ID No:64** nucleotide sequence of the proteorhodopsin gene amplified from clone PALE7 using PCR primers according to Sequence ID No:2 and Sequence No:3.

**Sequence ID No:65** deduced amino acid sequences of the proteorhodopsin gene amplified from clone PALE7 (Sequence ID NO:64).

ttgttatatc agtaatggct attgctccaa taacttaata ctaatatata attagtttat 60

gaataaattt tatatatttg ggttattgtt ttttacacta aatgcatttt cttgctcaga 120

tcttctagat acagacatga gagttcttga ttccgctgag tcaagaaacc tttgcgagtt 180

tgaaggaaaa gctttactag ttgtgaatgt tgcaagtaga tgtggttaca cttatcaata 240

tgctggcctt caaaagttat atgaaagtta taaagatgaa gattttctag taattgggat 300

cccatctaga gattttcttc aagaatactc tgatgaaagc gatgttgcag aattttgttc 360

tacagaatac ggtgttgaat ttcctatgtt ctcaactgct aaagtcaaag gaaaaaaagc 420

acacccattt tataaaaaac ttattgcaga atcaggtttt actccctcat ggaactttaa 480

taaatactta atctcaaaag agggcaaggt tgtatccaca tatggatcaa aggtaaagcc 540

tgattcaaaa gagcttatat cagctataga aggcttgctg taaaattatt acttagaaac 600

taatacagtt ttaggcttgt ttgctgcaaa tattccatta tctacaactc caggaatatt 660

attaatcaaa gcttccattt cagtggggtt tgaaatatcc atattagaga tatctaaaat 720

gtgattacct tggtctgtta taaatccagt tctatatgtg ggtattccac cgatcgagat 780

tatttttctt gcaacaaggc tcctactttc aggtatcacc tctataggca gtggaaaagc 840

tcccaaaaga ttaaccatct ttgactgatc aactatacat ataaactcgt tagaggcaga 900

agcaactatc ttttctctag tatgtgcgcc accaccacct ttaataagac aattttcagg 960

agacacctca tctgcaccat ctatgtaata agctatatca actacatcat taaggctaaa 1020

gacctctatc ccattttcat ttaataattt tgatgaagca tctgaactag aaacagctcc 1080

agcaaatttg tgcctatgct cctttagttc ttctataaaa aaattaactg ttgagccggt 1140

tccaatacct aaaatcatct caggatgaag attatttttg atatattcta tagcttgttt 1200

agcaacattt atctttgagc cactcataga gttataatac aagaaaatat aggtagttaa 1260

ttattttgag actaaaaatt aaaaaaacag gttcttttaa gaattcccag aagtacctaa 1320

agcttattcc taatgcatct gtttatgacg tagcattaaa atcacctata acatttgctc 1380

taaatatttc ttcaaagctg gggaataaag ttttcctaaa aagagaggat ctgcaaccta 1440

tattttcttt taaaaacaga ggagcgtata acaagattgt aaatttatcc gatgccgaaa 1500

agaagagggg ggttattgct gcatcagcag gaaatcatgc tcaaggggta gccagtgcat 1560

gtaagaaatt aaaaattaat tgcttgatag ttatgccaat aacaactcca gaaataaaaa 1620

taaaagatgt aaaaagattt ggagccaaaa tactccaaca tggggacaac gtagatgcag 1680

cattaaaaga ggcactgttt attgcaaaga aaaaaaaatt gtcttttgtt catccttttg 1740

acgaccctct aacaattgct ggccaaggga ctataggaca agaaattctt gaagataaaa 1800

ataattttga tgttgtcttt gttccggtgg gaggaggagg tattctagct ggtgtatctg 1860

cctggatagc acagaataat aagaaaataa aaattgttgg tgttgaggtt gaggattccg 1920

cttgtcttgc tgaggccgta aaagctaata aaagagttat tttaaaagaa gtgggcctct 1980

ttgctgatgg ggtggcagta tcaagggttg gaaaaaataa ttttgatgtt attaaagagt 2040

gcgtagatga agtcattaca gttagcgttg atgaggtctg caccgctgta aaagatatct 2100

ttgaagatac aagggttcta tcagaacctg ctggggcatt agcacttgca gggttaaaag 2160

cctacgcaag gaaagttaaa aataaaaaac ttattgctat aagttctggc gctaatgtaa 2220

atttccaaag acttaatttt attgttgagc gatcagagat tggtgaaaat agagaaaaaa 2280

tattaagtat caaaatccca gagatacctg gaagttttct taagctttca aggatgtttg 2340

gcagctctca agttacagag tttaactaca ggaaatctag cttaagcgat gcatatgttt 2400

tagttggtgt tagaactaaa actgaaaaat catttgaaat cttaaagtcc aaattaaaaa 2460

aagcaggctt caccttttagc gactttactc gaaatgaaat atccaatgat catctgaggc 2520

atatggttgg tggcagaaat agtgactcag gctctcataa caatgaaaga atatttaggg 2580

gagagtttcc tgagaagccg ggcgcgctgt taaattttct agagaaattt ggaaataaat 2640

ggmatatttc cttatttcat tacaggaacc taggttcagc ttttggaaag atattaattg 2700

gcatcgagag taaggataaa gacaagctaa taaatcattt aaataagtca ggnactattt 2760

ttacagaaga aacctctaac aaggcataca aagatttttt aaaatgaaag gttaatactt 2820

taatctaaat ttaattgaaa aaagctcatc gctagggttt tcccacggct ctttgaacaa 2880

ctcggattga gatctatcat cctcctcgtc gtaaattctc ccacctttag aatagaccaa 2940

aaatagatat gacaaaggag cgagctcata tttatatcta atttggaacg aagctacgcc 3000

agtattaaat tcattaacta tattatttcc tttataaagg tatccattag catctgaaaa 3060

aatactaata ggatttttg ctttcaaagc aacaaattga ctcttaagtc tgatctcatg 3120

tttattattt ttaaaccaat ttagatcaaa agataaggta tcttgtcttg aatcatatga 3180

ggcaagatta ttattatcct gccatatcag ccattcattt tcctttctta ttctatattg 3240

cgcattgatt cttaagttat catttggaaa tattgaacct gctatcttgt aaaattttct 3300

accataccca ttcgaatccc accgattatc tttctctccc ttaaagaagc taactctcca 3360

gtcatatgtc cagaatgaat agttctttgc ctcaaagtct gctgtaatac ctattcttct 3420

ttttgatttg ataaaggggt aggcttcatt ttttcttgtg atagttgtat ttttcccaga 3480

agatctaaag ttaaaatcta attgaaattt agagttgtcc ttaaaactaa aagaattttt 3540

ttgatcgatg cctattggat ttgaattacc agctgtgtca gcatcataat ttagatcaat 3600

tccataatct atttgtttta atatcgagct attatcaaat tcatttattt ttcgatttcc 3660

tccaatacca gcatgaatcc agtctcttct ttgcagataa ccaaagtcat ttaactcgaa 3720

gtcgtcttca aaataaagaa ggcttccact tatgttagat agtttatttg gaagatatgt 3780

aaactgagtc ctatacccaa gcccattttt accatctttt tctgaggcta acagatctga 3840

atatgtaatt aatttttttg aacgaatatt gatgtaatca ataacattga ctgttgatga 3900

ttcgcctgtc atttcattct caacattcgt taccatgaag ccaagcgttt tatttccaag 3960

ctttgttcga gatcgaagag cataatagtc tcttccaact gaaaaggctt catcagcctc 4020

acttgctaca aatactccaa attcattatt attacttttt tgagtaagtc ttaatgcaaa 4080

atcaatatca gaatagtttt ttttagctgc ctcgcaacct tcttcattac tttcttctga 4140

gcaattatag ctgggggcag ctccaatcct ccgcgtattt ataaccgagt atctatcata 4200

attactaata tcaaatagtg attggttttc attgaaaaat gctctttttt ctgagtaaaa 4260

agtttcttga gcagaaaagt taataaccac atcatcactc tcagcttgtc cgaaatctgg 4320

attaatagct aaatttattt gacgaccttt tccagtgcta taaaagattt cagccccaat 4380

atctgaccct tcttggtttg taactgaatt tttatttgaa gatatatatg gaaaaaaagt 4440

aagctttgat tttgtatagt tttgtatttc taagctatct aactcttgaa agtagtcatt 4500

tctactagcc attgttccgg cactgctaac ccatgactca ttttcggcac tataacgtaa 4560

tgcggtgtaa ttaatttttc ttatatcacc atcaggctgt ttcattaacg ttacatccca 4620

aggaataaaa aactcagaga cccaataccc atcaaatttt tgtgtttttg caatccaatc 4680

tccatcccag tctgtcttaa agtctcctgc ttgcgttttt atggcatcga aaagcgagtt 4740

cccaagattt atagcaagaa tgaaagcttt gttaccatca ccatcaaagt ctatatttat 4800

agagttttta tcgctaagtg aatttatttg atctctaagc gtcttcctgg agaacataga 4860

atcattactt tgaaaattct taaatccaac atatatacca tccttatttg agaaaattaa 4920

agccgttgta agaagttcat ttttcttaag agtaaaagga gatgtttcat aaaaatctgt 4980

aatttcaaat gcattattcc actcaggctc atcaagagag ccatcaataa caattgagtt 5040

tgaccaaatc agcacagagg taagtaaaag tgataatgag gctaaagtta ttttcataga 5100

tagatttaat tcagagtatt ttaatctatg aagagtagga aatcatccga tcattctcag 5160

aaaaaacata atcatattta aggtcatgtt tttctccaaa atgcatatta caaatctggt 5220

attgataaca cagtccaacc aataaaggtc ttgatacctc ctcgtttata gagccaataa 5280

ttctatcgaa atatccagag ccatagccaa gcctgtatcc atttaaatca actcctgtca 5340

taggaataaa cattaaatca atttcattta tgttgacata atcttcactt ttaacctctt 5400

tgatcccaaa ttgatttata aagaagttag gctgctcatc cagcaaatta aaagccatca 5460

tttcgtcatc aattactttt ggaatataaa tattcttttt aagtttagta aaagcttgaa 5520

ttaacaaatt tgtattgact tcatttcgaa aaggaaaata taaggcaatg ttttgcattt 5580

catgagtatt gatttttttct aatacatttt cttggattaa aaaacttata ttgctcttag 5640

ataaatcaga aatagactgc ccctgctcaa agagtgattt tcgtatttta tttttcacca 5700

taaattgtgc cgaggctaac aaaccaaatc accgccatgt gctatacctg aaccgatggg 5760

tcaggtggtg aatttcataa caaatcaggc ttccctgtaa aggtactgcg caacaatgct 5820

agaggaatat cacctattta attgtatcgg ttcaaattta ttaacacatt agcgtatgaa 5880

ccagaatgca gttaattata aaatatatag gtattaagta aaagttaatt tttagagagc 5940

agactctatt ttttgtatta gcttttcgat atctttatta tttaaagcag agtcagtatt 6000

ctcggttggc ttggataaaa gcttactagc catagttaga ccagctatca ccaaggcatt 6060

attcttatca ctgatgccat caagctcatc atttaataat tttgcagctc taatgagttg 6120

gtctttctct tctggcggac aggctaacgt cagatctcgg ccaaaaattc ttaaagatag 6180

cgtttccatt tctgacatta ttttttgagt ttagttattt ctttatttag tatgagctta 6240

tctttttttcc agtctctttc cctttgcaca taagaatcta ttattccttt ttgctcatca 6300

aatcttttta tcaaaagatc taccttatcc tctagttcaa ataatgatga ttttttttct 6360

tctgacattg tataagttta attgtactag aatgaattgg aaagtttctt taataaaaga 6420

gtaaaataag gcatggaaaa aataattttt aaaaacagaa gagattcact tataaaacac 6480

ctacctaaga attcagcctt aattgtacct ggtgcagatt tgcaatatag aaatgctgac 6540

tcatcttata atttaagaca ggaaagtagc ttctactatc tgtctggctt ttgtgagccc 6600

tcttctctaa tggttttagt taataatgga aaaagcattg attcaataat ttttgttcct 6660

gaaaaagata aacttaaaga aatctgggat ggttatcgag ctggccctga gggcgcaata 6720

aatgattttc tttttgatca agcttttgaa aataataaat cagatgcttt aatgcctgaa 6780

atccttcaag ggctagaaaa agtttttttat tcaataggga agaaaaatgg ctttgatcag 6840

aaagtaattg actggacatg cgcagcaaat tctaaagata ggcacagcaa atcaattgat 6900

attattgatg gctcttcgat ggtaggaaat ttaaggctta tcaaagataa gcatgaaatt 6960

gatattatga agagagcttg tgaaatttca gctgaatcat atattgaggt catgaaatct 7020

ataaagcctg gggacaatga gcaggaaata gaggcgctat ttttatatga attcgccaaa 7080

aggggaggaa ggtttccagc ttatacacct atagttgctg gaggtgaggg tgcttgtgta 7140

ttgcattata ttgaaaatga taaagagtta gcttcatcag atttaatttt ggtagacgca 7200

ggatgtgaat acaaaatgta tgcatctgat atcacaagaa ccttcccagt aagtggaaaa 7260

ttttcagatg aacagctaca aatttataat attgtccaca aagccaatct tgctgcaatc 7320

gatgctgtaa aaactggtaa tagcataatg gagccccaaa tggtttcaga aaaagtaatt 7380

actgaaggtc ttgtagagtt gggtattcta tctggcgatg ttaatcagct tcataaaaat 7440

ggtgcattca aggactttta tatgcataag gtgggacatt ggcttggact tgatgttcat 7500

gatgttggtg actacatgga gggagatgag tttatgaagt ttaagccagg gatgataacc 7560

acaatcgagc caggcatcta tatcagtagc gcaatggatg tagatgacaa atggaaaggc 7620

atcggcataa gaatagagga cgacatcctt gtaacagatt caggcaatat taatctaaca 7680

gagaaggtgc catctaatcc tcaagaaata gaatcattga tggcttagac tatggaggtt 7740

ccaattgtta tttctggcgg agggataata ggtaattaca tttctcttag gcttgaaaaa 7800

aataatatca aaaccgttat tgtcgaaaaa gctagtagtt tcaaagccct agataagggt 7860

ataagaacag tcactctcaa tgagcattct atgcaaatgc taaaaaatat tggtatttgc 7920

ccatcaattg ctcaaatcaa cagcatcgac gtattagatg gtgagggtac aggcaaaatt 7980

caatttctag caaaggacgt aggcagcgaa aacctttcat atgtaaccta tttcaatgaa 8040

ttacaaaaac taatttctga tccatgtaaa gaaagaacct tatttaataa tgagattgat 8100

tcagttcaga atcttaatac agaatctgat ccagagatca tgcttaaaga tggcatgacc 8160

ataaaaacga atctaattgc tggatgtgat ggaagaaatt caaatattgc aaaaattgct 8220

tcacttacaa gcagcttcga tgactactta caaacagctt taacttttgt cgttgatatt 8280

gataatgatt cacatggcaa agctcaccaa gtttttttctg aaaaaggaat atttgcactt 8340

atgccactcc cagaaggcaa gggtgagatg aataaatgca cagtggtttg gtcaataaaa 8400

aatcaagttt tgggagatga gcctgtatct gagtttgtaa aaaataacat ttctttttt 8460

gaatcaaagc ttaatgttag tctcagggtt aagtcagaaa ttttaagttt taaattatcg 8520

aaccatcatt ttgaaaacta tattagcgga cctattgttc ttcttggtga tgctgctcac 8580

tcaattcacc ccttagcagg tcaaggtatt aatctaggat ttgcagatgc agatactttt 8640

tgtgaagagg taattagttc ttataaaaaa gggattgcct ttaatgagaa atcagtttta 8700

aaaagatatg agattagaag aaaaagtatg aacttttaa tgttgaagtc tatggacttt 8760

tttgtggatt tatttggttc agaaaattta tatctaaggc tgatcagaaa tttaggtatt 8820

tcttcgttaa ataaatcaaa gtttgttaaa gcattcttta taagacatgc ctctggaatg 8880

aataagtttt aaatttgtat taaacttttt gacctttagc tctaagttct ttaagaactt 8940

cactaatgcc ttttttatca atgattctca taccttttgc agatacttta agatttacga 9000

acctgttctc agattcaacc caaaatttgt gtgtgtgaag attaggaaaa aactttcttt 9060

tagtcctatt tttagcgtga gaaacattgt ttcctgactg tggtatctta cctgttactt 9120

gacatatttt actcattgaa acgcgatttt atagaacact gaggaactta gcaatactat 9180

tgtgaaacaa atttatttat tacggcatgc acaatctgac tgggagagct ctaatcagaa 9240

agattttgat agaccattag caagaaaagg cattgaagaa gcaaataaaa tatcatgtta 9300

ctgcaaatct cattcaattt tagtagataa aatattctgt agcactgcag aaagaactaa 9360

gcagactttt gatatatgca gtgatgggct taattatcca atagctgaag cagtctatac 9420

tgatgagctt tacttttctg gccctggtga gatcgttaag cttatccaaa gtttaagtga 9480

attcatttcc tctgttttaa taataggcca caatccatca atgcaaatgt acatagatgc 9540

tatttcagaa aatcctcata ttacgtattc aacatgcggg ctggcagaaa ttctcgttga 9600

aagttcatgg aaagacttat ctttaaaaaa atgtaagtta aaatctttta ttcaaccagg 9660

agagctttaa aaattgaaaa acataaaaat taagatcatt aacccactaa tgggatccaa 9720

gataccctta cctcaatatg aaacaaaggg ctcggcagga ttggatttaa gggcatgcct 9780

agatagtaat ctcagccttc aagcaggaac atctcagttg atacctattg gttttgcaat 9840

gtacttagaa gatcccggtc ttgcagcaat ggttatacct agatcaggtt taggttctaa 9900

gcatggaatc gttcttggta atctggttgg gttgattgat tcagactatc aaggagagct 9960

aatggttcct gcctggaata gatcagatac agattttgag attaatcctg gagacaggat 10020

tgcacaaatg attatagttc cagtgattca agcagatttt gaaattgtag acgagttcaa 10080

tgagactcag aggggagaaa agggttttgg aagttcaggt ataaattgat aaatttactt 10140

tttcttgcca aatctttctt caaatttctg aactcttccg ccagtatcaa taatttttg 10200

cttaccggta taaaaaggat gagaagcaga ggatatatca agagggtagt atgggtatgt 10260

ttttccatct tcccattctt tcgtttgagt cgtatctaat gttgaacgaa tgagaaagaa 10320

cttatcagca ctagcgtcat ggaataaaac ttcacggtat tcaggatgta tatcttttt 10380

cataataaaa tcaaaatttg gatgagaact ataacaaaaa acaacttctt ttcaatcaaa 10440

acatgaaaat tttttactat gacatagctg tttcattgcc tctaaggcaa tgctttactt 10500

atagttctga gcttaaaatt acaaaaggaa cccgcgtgtc agttcctttt ggtaaaagga 10560

agattgtagg agtggttata aaaaatattc aaaagccaga tttcctaaaa aaagcgggag 10620

ctataaaaaa aattatcgct gtacttgatg aatatccttt gttcgacaag ccaatttttg 10680

attctatatt gtggtcttct gattactatc atcatcctat tggtgaggtt tttaatacct 10740

ttatacccac cgaattaaga aaaattaata ataaaaaaat tgaagcttta agagaatttt 10800

ctgaatattc agtaaatgag gatgataaga aattcgattt aaccaaggat caagaaaaag 10860

cagtcaaggc gctttctaaa tctaaaggat tttcacccac tttattatat ggagttacag 10920

ggtctggaaa aacagaagtt tacttaagag ttgccgaaac ttttattaaa aataataagt 10980

cagtattagt tttagttcca gaaataaatt taacccccca attgctctcg cgatttgaga 11040

atagatttaa tggtgaaatt ggcatatatc attctaagca aacagcagct aagagattaa 11100

agacttggct aaaagctaaa tttggttcta taaaaataat agtaggaact cgatcttcgg 11160

ctttagtgcc tttagataac attggtttaa taattatcga tgaagagcat gaccaatcat 11220

ttaggcagtc agaagggttt aaattctctg ctagagactt aagtataaaa agggcacagc 11280

ttgcagatat tccaattatt ttgggatcag caacccttc gctgcaaact ttaaaacttg 11340

taaaagaaaa taaatttata agagttgata ttcctaatcg agttgatgga aacaagcctc 11400

ctaaattaat agccttagat atcaataaca gccctttaat aggcggagtt gctaaagaga 11460

caattgaagc aatgcaatca accatagaca gaggagaaca ggttctagtt tttattaata 11520

gacgaggatt cgctccactc tatcaatgta gtagttgtgg gtgggtagca gattgtaaat 11580

cttgtgatac aaatttagtc ttccaccagg caagaaatag attaatttgt cataggtgtg 11640

aatctgccta ctctgttaat ttgtcttgtc cggcatgcaa gtctaatgac tttaatatgt 11700

atggagctgg aacagagaga gttgaagaag ttcttaaaag cagctttgta aagactccaa 11760

taattagagt tgatcatgac tcaacaaaaa aagtgggagc tatggaggct atagttaaaa 11820

aaattcattc ctcagacgca gcaattttag ttggaactca aatgcttgca aaaggacatg 11880

attttcctaa agtcaccttа agcgttattt taaatgctga taatggcctt ataagcccag 11940

aaattaatgc attagagaaa atatctcaat tgcttattca ggtctctgga agagcaggaa 12000

gaaataataa tcttgcaaaa gttattattc aaacaagata tcctgatgat ataaatctta 12060

ataaaattaa gacaggagat tatatgaaat ttgcttctca atgcctaagt accaatgagc 12120

aaatgaactt acctccattt actactttat gtctgcttag gtgctcatca ccaactcaaa 12180

agagtaatgt agatttccta gagaaagctg ttttaatttt atccaatagg actgatataa 12240

atgttattgg tcccttgcct tcattagttt cgaagtcgaa aggaaattat aggcaccaag 12300

tctatatcca tgcaccaaag aagacttttt taaataaggt attaaagttt ttgacaacag 12360

agtttgaaaa atggccggaa tctaataagg ttaagtggtc tttcgacatt gatccaatag 12420

acttaagcta aatattaatc ttaattaatt gtcctgggta tattggttta ttgtttagtt 12480

tattctctgt attaatttct tctacagtca ccccaaatct tatcgctatt tctgataaga 12540

catccccttt ttgtattttg taagtcacaa agcctggatc aatactcata aaggtatttg 12600

ctttaggttt gtccttaaaa tagttatgta ttcctaggaa aacagatctt gcaatcattc 12660

ttctccctgg cttgcccttt aatctttgtg cgtcttcagg gttggttata aaccctgact 12720

caaccaatac agaaggtata tcaatagact taagaactct gaaatcagcg tactcaacat 12780

tctttttatg aatttttgtg aaagggtctc ttttaagttg atccaatatc ttagttccta 12840

aaattttact ttcagaaatt tttttcttat atatttctgg ataggtttgt cttgccgcat 12900

cctcatcaaa atcaactggc tttagatttt ttatatcagc ctgtattctt tccctttgtt 12960

ttttagataa gttcctagca acagtacttg aagcttcatc tgaccatata aaaacagaag 13020

caccctttac ggaagataat ctaaacccat cagcatggat tgaaacaaaa atatctgctc 13080

catatttcct agcatcctgg tatctattat ttaaatctaa tgtctcatct ccatctctaa 13140

tcatcaccgg tctgtaccca taagtatctc ttaaggttct ttctaactcc ttcgcaataa 13200

gtaacgtcac atctttttct aaaatattat ttgggccaac cgcaccaggg tatttaccac 13260

cgtgacccgc atctatagca acaacaatat ctctaatact tttattgagg tttttatttc 13320

ttttcacctt aagctctaat tttatatttt ctgtatttat agtctgagtt gggttttgcc 13380

aatggactga ttcatataaa tcaacaacga ttctggtaag acttccatcc tgagatgctc 13440

ttacttttt gattggatag ttgtatggaa catttatctc ggtcggaagg ctcgattgat 13500

taatttccat gacaattcta gagggatttt taaagaataa gaccttacca atgaaacttt 13560

atctagacta aagttaatac taatttcatt gttacccatg tcttgtattt catcgaagaa 13620

aacatcattt ccgctgataa aaaaagatag aaaaccaagg attgccaatc tattcataag 13680

tttttaacca ttctttaaag ccattgtcac cagaaattaa agaaacctct cttccttcag 13740

gaagatggct gaaaattatt tttagatcaa aacttctttc atgttgaagc ctttcaggcc 13800

actcaattag cactactttc ttagagttta tttttctact tagatcaaat atatcaatat 13860

cttctgcttc gttagttcta taaagatcaa tatgcaaaaa cattaaatta ttaaaatcat 13920

attcctcgca gagagtgtaa gttggacttt ttacaagatc cttccatcca caatttttta 13980

taatagatct agatataaag gttttgcctg ctcctaagtc tccctcaaga tgtatttcaa 14040

tttcttgcga agaagattta agtatctcca tagctatttt tgaccctagt tggtttgtag 14100

cctcgtcatt tataagagta agtttttca tcgatttatt aattgtctta ttataggtat 14160

taaactagag gcatttaagc ctatttcacc aatatctacc ttaaatttta aacctgcctc 14220

cgaatgaaca gcaacagcaa taatgctcgc atttcttata tcaagacctt gggcaagaag 14280

agcagtcaaa acaccagcca gaacgtcacc agttcctcct gaagcaagtt caggtccgcc 14340

gcacgcgcat ataaaagact tgttatttgt tgagtcaaag accaccgttc ccattccttt 14400

taatatgaca atagaagccc cataagtgtc tgcaatttgc ttggcagcag aaatcctatc 14460

tctttgaact tcttcaatag atatgtttag taatatagcg gcctctcctg gatggggcgt 14520

catcaagatt gttttattgg atttttttgat taaagatttt gatgatgcca cgatgtgtaa 14580

agcacctgca tctaatataa tttttgaatt atttgcagac tttaatattt tacccaatat 14640

agtttttgca aaagcagtat tagcaattcc tggtccatac aatataacgc tatgatcttt 14700

aatttttaaa tctatatcga ccccttcaac catatcaaca ccaattgcca ttacctcagg 14760

gtttcttaat aaagatgggc ttacattaga cgtgtctgtg acgagagtta ctagtccaga 14820

gccacaaaat aaacttgcct cagatgcaag tattccggcg ccacccatgc ctggggagcc 14880

agcgcatatc aaaacttttc caaaattacc tttatggcta tcctttgctc tattgggcag 14940

aagatttttt aattcttgaa aggtaaaact ttgcaatata gacatgaaat tacttaagct 15000

aaattatgtt gaatgctaaa aattcattct tcagcgaaat aaccaatcct atcggaatgg 15060

aatgatccca taaaaatttt ttcgtcatga ggcactgcaa tagtgggtag gccaaaaact 15120

gttctagaaa atgaaaactt atcttctctc ttaagtgttt tttgattaag tttatgaatg 15180

gagaagggta gagaacaatt tgtttttttct gcacaattac caaaatcatt agcctgtaaa 15240

tctaaagaag ttaaccaaac cgaaccgtct tttaaaaaga tattatctgg actctgaata 15300

aaataactac ctgttttagt attttgatta atatcgtaaa cagataaatt gtcaccttga 15360

ttatagttaa cataaagaag tccagagccc tcatctagca aaattccatt aggcccactt 15420

ccatctgttc catcaacttt attaaaatta ttgtcactcc aaagtactac atgccctgaa 15480

atacttttaa ataatgaatt cattaaccat tctttcatgc tgatatctct tttatacata 15540

tgagatgcat aaaaacttcc atctttttta agggcaacat cattgaaata atattggtca 15600

gggaccctaa tacagccccg ccatatcata tcccatgaag attcattttt tataatttca 15660

aacatttcaa tcgactcaaa tggcgaatga ttaattacag ctagttgata gaagccttca 15720

tcattttcaa caagatctat tccgtgggga ttgaatatgt ctagctcgcc tcttatgcat 15780

gaagcgtcac cccaagagct ttctccaaaa gtaatttttg gtacctttt ttcataggta 15840

tttaaatcca ttaaggcaaa gtaaccaggg gtatgttctg catatggacc gatccctcca 15900

aattcagaaa taaagaagaa tttattatca ggcgtaatca caatatcttc tgggtttgag 15960

aaattacaaa taaccttgat acggtcatcg gattcacact tactaatatc catttggggg 16020

cctatatagt cagtagatac gacagttaca gaaataaata ataaagaat agaaaccggg 16080

acggtaatct tataatagtg ctttataaaa atttctaaaa tctttgaagc atgatttgga 16140

agtgcgatca gccaaacccc ttttaaaaaa gatagagccc ccataacaac aaaaattact 16200

gaccatagcc tgtcagacca ttccggctga agaagaccag ttaaaaaaag aatcatccca 16260

aagaataaag ctaaatagcc tgagattttg actttcgatc caacaaattt cgaaaagaga 16320

tatgtataaa gaggctttat aagaactagt aaaccacagg ccaagaaaaa gaatgctaag 16380

tagtaattca taagttagtt tttatataaa tgctccttaa taatactaac aagttctaag 16440

ggcttgtcca atggaacatg gtgagcagct ccaggaaccc cctcaaaagt cataatgtca 16500

ccatatgtat ttttaatatt gtccaagata cttccggagg ttaataagct gtcttcaccg 16560

tggatgaaca aagcagggca gccaaatgaa aatgtgtaac cgaataacct ttcaagactg 16620

ctaaacatga catcatcaaa tttccatctc cacccagcct caatattttt tactgagtgc 16680

tcagcaatgt atcttaagta ccaatcattc gtacaatctt gcttaggcat taacctaaac 16740

cttttaataa tatctgtctt gtcttgatag tgcttgatca ttctgagagg agaagagtgt 16800

tgattcgggt cataatccgg tggtcttata aatgtatcaa taataataat attatttatt 16860

agatcctttc tttcagatgc aacgtaacca gcaacatgtc cgccgaggga gtgtccaaca 16920

ataaaaatat ttgaaatatt ttttttatcc ttttcctttt caattacaga gacaatacat 16980

tctccaaaat ctttaatgcc atatgaatct ctaaaagaag agtcacccat gccaggaaga 17040

tctattgcaa ctatatttgc gcagtctcta aagtggggcg caataggatc ccaccatttt 17100

ttatgagcac ctgttccgtg aataagaatt attaaatctt tgctttcatc tttggagttc 17160

cagctagaat aggatatatc cccatgagga ttcttgataa tctctgagct aggcttgtcc 17220

tcaatggcat ctttgaacca ctgtggggca tgaataatgt cttgatttag attgttagtt 17280

atttccataa acagtattct aagctataaa aaataaaaat atgaataaac ttaatttaac 17340

gccagcagca actgttttag tcctaaagga ttctcctgat gggatggaag ttttgatggt 17400

aaaaagatca agtaggcctc ccttcggaga ccttttttgtt ttcccgggcg gcaagattga 17460

cgaaggtgat ttcaataata agatagaaga tttttgtgag ggcgtgactg ataaagaggc 17520

ctccataaat cttggattag attctggagg tctagcatat tgggttgcat gtattagaga 17580

atgctttgag gaggttggaa ttttacttgc taaaaaaaag agtggggaag atcttgatct 17640

agatggagtc gataaacata aatatcaaaa atatagagag atgttgttaa ataatgaaat 17700

tgatttatat aaaatctgtt tagaagaaaa tttaattcta atgcctcaac aaatagcccc 17760

tttctcgcat tggataaccc ctgaaataga aactaggaga tttgatacac gtttttttat 17820

tgcccacctc cccaagcatc agaccggaga acatgatggt agtgagctca tagacagtgt 17880

ttggatttca ccaaaagaag cgctcaaaaa atctcgttcg ggtgagatgc ctatgattat 17940

gcctacaata aaaaatttgg aacaatgtgc acaatttgat tcgggctcta agcttttaga 18000

aaatcagagg aatctctcaa atgaggatat cccaccaatc ctgccaaagt tttttaaaga 18060

agatggtgag tggaggggtc tattgcctgg agataaaggg tatgaggatc attaaataat 18120

atggacttaa ttactaaaat aacagctccc aaccctggtg ttttcactgg gggtgggact 18180

aatacttatt tgattggcaa agatgatata acccttgtcg accctggtcc aaatatatct 18240

gagcatctag atgaaattat caaagcaggg gatgggaaaa taaaaagaat ctttgttact 18300

catacccata cagatcattc cccagccgca ttgcctttat caaaaactct taatgttcca 18360

atgtacggaa ggctagtaga tggtgaatcc tcatgggagg atgaaacatt tatcccagat 18420

attattttaa atgataaaga tattattgag acagacgaat atacgttaga agtaatacat 18480

actcctgggc acgcatctaa tcatttatgc tttttaataa aagatacgaa atgccttcta 18540

acaggcgatc acattatgga cgggtctacg gttgttattg ggccaccaga tggcaatatg 18600

acaagctata tcaattcatt agaaaagtta ctagattttg atattgattg ctttgcgcct 18660

gggcatggaa attatattca tgagcctgag aaaaccattc aatcaattat taggcacaga 18720

ctaacaagag aaagaaaagc tcttagaaag ctaggagagg caggaatctc atcattagat 18780

aaacttacta agcttgttta tgatgatgtg tcagagatgc tccatcctat agctaaatat 18840

agtctagaag cacatttatt aaagcttata gatgaaaaga aagttaaatt agataaagat 18900

ctattcgaaa taatttaatc ctttttattt ttatgtaaga ctttctcctc aatagcttct 18960

atatcaatat catcaattga gtcttcgtta ttatcaggta tctttttttac atctttttca 19020

attttaaggt cgataggaga ggctccaaga tcaaaagtta gctcccttac atttttttgaa 19080

atagtatcct caacacagtc atcttgatcg tatgcctcac gggtctctcc tttatcatta 19140

atgggaaagg gtctttgggg agggcccatt tgcatgcatt taatagtagc aactggtgag 19200

tagtaatcgt cactagaata taacttatca agttcttttg gtgatattga gcaaccaata 19260

attccaaata gaataaatgg cgctaagagt cttttcataa actttgtttg ttttctataa 19320

gagactcaac aaccgaagga tcggcaaggg ttgtcgtgtc tcctaaatta gatagatcat 19380

tctcagcaat ctttctaaga attctgcgca taatttttcc cgatcttgtt ttaggcaagc 19440

ctggagcatt ttgaattaaa tctggttttg caatagctcc aatttcttta gcaacaaatt 19500

gtttcaattc ataactaaag ttgtcatcaa atgattcatt tatcattaaa gtaacaaaag 19560

catatattcc ttgcccctta attggatgat caaaaccaac aacagctgct tcagcaattt 19620

tagggtggag cacaagagca ctttcaattt cagctgtacc tagtctgtgg ccagaaacat 19680

taagaacatc atcaactctt ccggttatcc agaagtatcc atcctcgtct cgcctggctc 19740

catcaccagt aaagtaaata tctttataca taccaaaata ggtgtcgatc attctttggt 19800

gatcaccata aatacttcta atttgactag gccaagattg ctcaataact aaattacctg 19860

cattagagcc ttctagcgta tttccatgct cgtcatagag agatggctta actccgaaga 19920

agggcagagt tgctgaccca ggttttgttg gagtaatacc cgctattgga gagataagta 19980

cagaaccagt ttcggtttgc caccaagtat caataacctc gcaattagat ttaccgacaa 20040

cactgtagta ccaatcccac gcctctggat taattggctc tccaactgta cctaaaattc 20100

ttaggctatc tctttttgtc tttttaacag gatcatcgcc ttgggccatc agagctctaa 20160

tggcagttgg agctgtataa aaaatactaa tgtcatgctt atcgcatatc tcccaacacc 20220

ttgatgctga agggtaggtt ggcactcctt caaacataag tgttgttgct ccatttgaaa 20280

gaggtccgta caagatataa gtatgtcctg ttatccatcc cacatctgca gtacaccagt 20340

atttgtcctc tggccttatt ccaaaaagat atttgaaact aatatgagcg cctaatagat 20400

aacctgcagt agtatgtaga acacccttg gcttgcctgt agagcctgat gtatagagaa 20460

tgaaaagagg gtcttcggaa tccataggct ctggagcaca cttattagaa acatctttaa 20520

caagatcttc ataccaaaca tctttttat catcccaatt aatttcgcca ccagttcttt 20580

ttataaccag tgtattttta acatctggac agcccagaag agcctcatct acattagatt 20640

taagtggcac ttttttgccg ccccttaaac cttcatcagc agttataaca attttacaat 20700

cagcatcaag aattctatct ttgagtgatt ctggagaaaa gccaccaaag acaacagagt 20760

gcacggcacc tattcgcgtg caagcaagca ttgcgaacgc agtctcaatg atcataggca 20820

tataaataca aactctcgag ccctttgaa cacccaggtc ttttaaaaca ttagcgaact 20880

tacatacttc gtcatggagc tctttgtagg tcaattcttt agaatcagca gggtcatctc 20940

cttcccatat taatgctatt ttgtttggat cattttctaa atgcctatcg atgcagttta 21000

agctaatatt tgttttacca ccctcaaacc acttcgcatt attaaattga ttattgaatg 21060

ttgttttgaa gtcttccatc cagcttatgt tttcgtttgc tagattttta aaaaatttag 21120

aaggatcttc tatggattgc ttgtaaagtt ctttgtattc atcaaagtct tttatataag 21180

gattacttga atgttttggg ctataaagct ttcgaggcat tcttaaataa ttgaaggttg 21240

ggggttaatg aaattctttc ctttgggatt ggacattatt tttgtaatga gcgattcgta 21300

atcgctatca ttggtttcta aattaatatc tgcagcatta attattaata aaggggcaga 21360

actatagtct aagaaaaacc ttgagtatgc atcattcagt ctttccaggt agtcaagagt 21420

tagatattgt tcgttaatat ttcctctctt agtaatcctg tcttttaaca catcaatagg 21480

tgcctgaaga tagattacta ggtcgggtgt tggcgcgtcc agggttagat ggtcatatac 21540

tttgtcatat agatccattt cctcgttaga aagagtaacc tcagcgaata atcgatcttt 21600

ttctattaaa aaatcagcaa ccctcactgt ttcaaaaagg cttctttgtt taagatcttg 21660

aatttgttgc attctttgaa acaagaagaa aagctgagtg gctagagctg attggcttgg 21720

gtttttataa aaattcttta agaagggatt ctctgccggt tgttctaaaa aagaatcata 21780

attaaatgtt tcggctatct tatttgctaa agtagttttc ccaacaccta tcggtccttc 21840

aattgcgata tattttggaa gtggtacttc tttaatagct gggttcattt ataacgtata 21900

gtttttatcc tagattatct caactcgtta tagaagccaa atatttttgc agattcttca 21960

tcacttttt cattcatctc agcaataatg gttcctctca atgagtcatc atttttttgg 22020

aaatcagtcc accacttccc aataccactc ttgtctccag aagctctctc tcttacaagg 22080

agaaaatcat atgcagctct aaaccttgga tgtcgaagag ttttatatgg ctggctacca 22140

attctgctat gaagttttaa ttgaagtacc caaatatcct taatatagct tgaaaatttt 22200

cttggtattg ctgtgatttt ttgttgttcg cgaagtacac catccataga tcggaaaaat 22260

tttctcacat taatttctcc attcttagaa cacttttca ataacgaggg ccataacaat 22320

gcagccataa gaaagcctgg tgtaattgac tgttggtttt taaccctatc atcagtattt 22380

cttagagcat gtgtcataac attgctggca aagtcattcc tacttggatc agaaaggata 22440

agatatttat ttaaatgaaa tgagcagagt ttttcaaaat tcttttcacc cattccattc 22500

aaaaatattt tgcagaactc atcaaacaat ctagcgtttg agatgcctga taaaagatgg 22560

cctttatcat agatggcatc cttaaccaga ttatctatct taaaattgag tttgttacta 22620

aatcttatag ctcttaagct tctcactgga tcttcttcga atcgtctttg gggatctcca 22680

atagatacaa taaccttctt gtgtatatgc ttaagcccat cgttatgatc ttctattttt 22740

tttgtaacag gacagtagta aagggcattc acagtaaaat ctcttctatg acaatcttgt 22800

tcaagagtgc cccaattatt atctctaaga atctttcctg tcgaatcagt aacaatattt 22860

tcaccatctt cctgatcact tcctgatctg aaagttgcta cttcaagcaa ttcactccta 22920

ttaaaaacat gaaccaattt aaatcttttg ccaattattc ttgaagcttt aaatgttttc 22980

ctgatctgct caggcgtggc attagtggct atatcgaaat cttttggctc tagtcccgtt 23040

agtgcatcgc gaacgcaccc accaaccaga taggcctgaa aattattttt ttgaaggtct 23100

tgaacgacag atatagcaaa tttacttatc ttattattat ctatcaaatc taattatgaa 23160

tttttatgat ttaagggcat tagccattta gctgcttttc tttaatttcg tcaagtgttt 23220

tgcaatgaat gcaatgagtt gcagttggtc tagcttcaag cctcttaatt ccaatttcat 23280

caccacagga ttcgcaccaa ccataatcat cttgcttaat ttgttcaata gatagaccta 23340

ttttgctgat aagttttctc tctctatctc tggttcttaa ttcaaaagca aactcttcct 23400

cttgagaagc cctgtctact gggtctgcat aggtttcacc tttagctcta agatgatcaa 23460

aagtttttg catttcatcc ttaagatgtt ctttccaaag aagaagaacg gcaacaaaat 23520

gtttcttcat tgctgcactc atatattttt caccttctt agatttataa ggtgcaattt 23580

tagatttatt attagctatt gttgcttttg cagacttctt ggctgcaact tttttaactg 23640

gagcttttt ggtaacagtt tttttaactg tagcttttt ggcaacagtt tttttaactg 23700

gagcttttt tactgtcttg gattttttt cgaccatgta agattttata gaattttagg 23760

gtggagaaaa tatcagatac tgacaaaatt agctagtcat tttttaattt atttaatact 23820

ttcaagtacc catccgagct aagtcttggc ccaaatgtct caacaacctt ggaagatgca 23880

tagtttgcaa acttagcaca tgcttcaata ttattccctt gaaggtaggc atgcataaac 23940

gatccggcaa acatatcacc agctccattg gtatctattg gagttatttc ttctgcttga 24000

gcatgcttct caacccctttt atctataaca acacttccat cggcgccttt tgtaatagca 24060

gtcatatagg gcttttcttt ataaaagcta acagcatcat caaggctttc tttaccagaa 24120

aaagcaacag cttcatcatc attacagaag atcatatcta ttccatatga ctctattaaa 24180

tcaaattttt ctttaaaacc atgaacaata cctgcatcag aaagagacaa ggctttcttt 24240

acgtccttgt ctttaaggtg ctctaagact gaaataacag cattaaagtt atcgtcactt 24300

gttaccatgt agccttcgat ataaaaaatt tttgaatttt ctacaacatc aaaatctata 24360

tctgatttac caagatacgc actaactcca agcatgctgc tcatagttct cttagcgtca 24420

ggagtaacta aaattaagca tttcccagtt ggttgatctg tattttcaga gctgacacca 24480

atatgtttga ctccagccga cctgagacta tcaagatagt ttcttccatc ttcatcatca 24540

gaaactctgc atacatgatg gcaattcgaa ccataatttg ctgcagcaac aagagaattg 24600

gttgcagagc caccgcaatc agaaatcgat tcggctccca tttcaataag tttgctaatt 24660

ataggtgcct gttcttcaga agatgaaaga gtcatagagt cggctacaag gcctacactt 24720

gataaaaatt catggctgac tttatattga gtatctacta aagcatttcc aagggcgcta 24780

atatcatatt tcatgtgtta ttccttttg tattatttgt tttactgttt ctaacgttct 24840

attaatttct tgatccttat gcattgctga aatgaagcct gcttcatatt tagaggggc 24900

aaagtatatt ccacttctaa tacatgaatt taaaaaattt gaaaatagta catcatcagt 24960

ttttgcaaca tcattaatat tattagggag ttcttctgaa aaaaagaatc cgaacattcc 25020

accaattctg tttatagaaa acggaatacc tgactcaatc attaaggttt tcatcccatc 25080

caaaagcaca gatgcatttc tttctaactc tttaaacgga ttttctttaa tcaacaattg 25140

caacaaagca gttcctccag ccatagctag tggattgcca gacaaagttc ctgcttgata 25200

gacaggacca gaaggagcta gatagttcat aatttcttct ttgcctccaa aagctccaac 25260

aggaagaccg ccacctatta ctttccccaa agcagttaag tcaggagtaa tattataaat 25320

ttcttgagct ccgcctagcg aaactctaaa gccgctcatg acctcatcaa atattaaaat 25380

agaattattg gctgaggtgg tttccctcaa taactttaag aaatcttcat gacctggaac 25440

aaagcccata ttccctgcta ctggttcgac tattacggcc gctaagtcat cttttatctc 25500

attaaatatt tctaaaaact gttctttatt attgtattcg caactaaatg tatattttgc 25560

caaatctgca ggaacccctg gagagtcagg taagccaaag gtggcaaccc cagaacccgc 25620

cttaattaaa agagagtcaa catgaccgtg ataacagcca tcaaatttaa taattttatt 25680

ccttcctgta aaacctctgg ccaatctaat cgttgtcatg gttgcttcag tacctgaatt 25740

aaccattctt atttttcaa ttgaaggaat gcatttttta attagcctgg ccacatcaga 25800

ttcaagactt gtcggggcgc cataactagt tccaagcgca acttgatttt taattgcacc 25860

tacaatgtct gggtgtgaat gacccattat catcggaccc caagacccaa tataatcaat 25920

atattcatta tgatcagcat cataaaggta tgcgccggat gctctttcaa aaaatatagg 25980

attgccattg atatttttga atgcccttac tggtgaattt acccctccag gcataagagt 26040

cttggcctct ttgaataagg ctatggattt atcaatttta ttatgtgtca aagctaattc 26100

ttcttaattt ttaatttcga tatgatatca acttaattct tattatgtat ttaattgttt 26160

tgaaaattca tccacagtat tccagttggt gaactcataa gtatttgtaa catctgtagg 26220

acccttttgta atccacataa tcaatctaat catgtgttta tctataaatt tatattttgg 26280

ataatctatt ttgcctgcaa agactgctaa tttcattggg ttccaaggag acagctctaa 26340

aaatttttgc atatacgggt ttgtttcagg tgtatttttt tcaggctttc tcgcaactac 26400

attaactgaa aagaaggcat tttcttttgt ttcaagacaa gcaacatttt tttgaataaa 26460

ttcataaagt tctggtttgt gtttgccata cctaatgctc gcaccaataa taattttatc 26520

aaattgatat aaatctaact ctactgcttt tgcaatatgt attatttttg aagattcaga 26580

cacatctaat ttagagaaaa ttttttttaca aatttccaga gtttgcccat cggttgtaga 26640

gtagattagt agagttgatt tcataaatat attttatatt gttaattaaa aaatttcatg 26700

gcacgcgcaa aatataaaca aaaatatagt atatttaaaa aatgattaaa tatttattta 26760

ttatcgcttt attcatcagc aactttgcat atgcaaatat tgatgcagct aggtgcgcag 26820

ggattagttc agatcaagaa agacttgatt gctatgattt aatttttaaa gctaatgatg 26880

agctaccttt agatagtaat attaaaactc tcatcacacc agctatcaag gctgtgaccc 26940

cagctgattc aataaaaatt gaaaataaag caacaaaaga aaaggatttc gggcttccaa 27000

aaacaaaaat caaaaactct gcaaagaact caataaaaac ctcggtagta aggattaaaa 27060

aaacaaaaag tggtaaatta atttttactt tagaaaatga gcaagaatgg actgctgaaa 27120

cttcttatag agcaaggaat atgtttaaac cagaaaccgc agtcatttta gaagaggccc 27180

tggttagtgg tttttatatg attaatataa gtaataaaca gaaaattaga ataaagaggt 27240

tgaaatagca atgaccatac agagtatagc aacgaccgag ggtgccatga aaagaataag 27300

atctgttctg gggtcccaag atggctcaag cttcagggtt tatgttaccg gaggtgggtg 27360

ctctgggttt caatatggct tcaagtttga taacgatatt gcattcgatg atgatgttat 27420

aaattgtgga gatttctcgc ttttaataga ctctatgtcg tacccctatc tttatggatc 27480

aactctggat tttgttgaag atctctcagg ggctaaattc gttattaaaa acccaaatgc 27540

caaaacaaca tgcgggtgtg gagagtcatt tacagtttag attttgtaat tgaacccaaa 27600

agtcctttta cattcttgct tgatgtctga actatcagag cctcattact gactctttta 27660

tatcccatcc aggcaaatgc catggactca atagcaaaaa catcatggcc taaatcactt 27720

gagaggacga tatcattact agccatctca gaaattcttt ttaccagata cttgttatgg 27780

gcaccaccgc cacaaatgac aatgtcacaa ttattatgac cattttatg gattgaattt 27840

attatagatt ttgctgaaaa ttcaaccagg gtacatagaa tatcttcagc tttcttttt 27900

aagaatttct tggataatat ttttatatta aagagctctt tgcctgttga ttttggacat 27960

tttcttttaa aaaaattatt ttgaagcaat cttcctaact caatgtgatc tacttttcct 28020

ttggctgcaa ttgcaccatt tttatcaaaa ggaatctgaa gaaaatcact acaatatgca 28080

tctaaaattg cattaccagg gcctacatca gttccccata tgtcatttct atttttaca 28140

aatgagtaat ttgaaatccc ccctatattt aaaataattc gtgggtttct agctttataa 28200

aataattgat tatggaattc cggaacaaga ggggcgcctt cgccacccag agcaatatgc 28260

atatttctaa aatcacttac caccagaagg cccgtttctt ttgcaacaat atttggatca 28320

ccaatttgca tagaaaatgg aaatctctta ttaatttcat gcctaatggt ttgtccagaa 28380

atagcaacac actctataga tgatttctta attttactaa atccaatcgc ctcattaata 28440

gattttgaaa ataagaatcc tatctcttta ttgatagtgc ctaaatctga caacgagctt 28500

tcgttatttt caataagttt ttttactttt aatcttaggg attttgggaa tttaattgaa 28560

tggaaatact caagatgtat ttttgtacca atgctaagaa atgaaatatc aatagcgtca 28620

tgactagttc ctgtcattgc tccaatatag atctttttac tcattactac ttggagaaag 28680

tttattgaac tcctccattg ataatttatt attctttaat agtgtatcaa aacttgccct 28740

taaatttttt ggtactggtt cagctgatgg taattttact tttataggat ctattctttt 28800

cttacctatc ttaaactcat aatgtaaatg aggccctgtt gccagtcctg aactcccaac 28860

gaaaccaata gtatcgccct gagaaacttt tttgcctttt cttataccct tactaaattt 28920

ttctaaatga caatatctag tcgaatactc atttgtatga tttataacta tctcattacc 28980

acatccattc ctttgaccag aaaaagaaac aatcccatcg cctgtagttc tcaccggcga 29040

tcctcttttt gctgcataat cgactccatt gtgagctctt attgtatgaa gaacaggatg 29100

cattctgttt ggattaaaat gagaactaat atatgcaaaa tctaaagggg ctcttaaaaa 29160

ggcctttttgc atattatttc cattttcatc aaagtactgt tttttactgg cttcagtgaa 29220

aaacctattt gcaaaatagg tattaccatt gttaataaac ttagcaatta cgatatcgcc 29280

atttttttact ttctctccat cactataagg agtgtcataa attacatgaa attcgtcacc 29340

ctctctaata tcaaaaacga agtctacatc ccagccaaag atataagcaa agtccataat 29400

cacactttcg ggaatatttg catctagagc tgcctcataa aatgaggatt gaataatccc 29460

gctattgtaa gattcaatta actcaatact tttgcttata ttcttaaata ctatttctgg 29520

agtaaggcta attgaaatag aatttatttg atctttcatg atctcaattc tggttagctc 29580

ctcaccagaa tattcaaaga gcatttttc ccctggttta atgttagcaa tgatattttt 29640

ggagtctaat ctaaaaattt tataagcagt atttaaaggc actgaaaagt tttcaaaaat 29700

tattgaaaga ttttctccat cttgcacctc atgcatctga tatgttttcg tttgctcgag 29760

aggtatagag aatttttcag taatctcaat ttcttcaact ggcaaagatt catatgtttc 29820

tatatcaata taaagcatta atattaagac aatagaaaca gcaaaagaaa caagtaccgc 29880

tctttttgga actttttttaa aacctatcat tagtcctctt gaatatttaa gagttcagtg 29940

ttgccaccaa atgctaccga gttctttgag acaacctttt cgttaagaaa ttgcagaagg 30000

taattaggcc caccagcctt ataaccgctg ccggatagat tttgtccacc aaaaggctga 30060

gaaccaacaa cagctcccac catatctcta tttatgtaaa tatttccaac attacacttg 30120

tcactaaata tgtcggccct tttttctact ctagtatgaa tacccattgt aaggccgaag 30180

ccactatcat taatattttc aattagtgca tccatttcat ttgatttaaa tctaacgata 30240

tgaagtattg gtccaaattg ctcgtctttt agatcagaaa tattatcaat ctcaattatt 30300

gttggagcta caaaattttc atctacatta tcagcagacc taaaaataga ataattctta 30360

tcttcaaaac ctttgacgta agcattgaga ctatcaagag atgttttgct aattattgga 30420

ccgatatctg tgtcaagatt ttgagggttt ccaattttta gttctttcat accaccctta 30480

atcattgata aaagatcgtc atatatttcg tcttgtacac agagaactct caaggcagag 30540

catcgctgtc cagagctatc aaatgctgaa cgaataatat catcggttgc ttgctcgaga 30600

agtgcgcttg aatcaacaat cattgaattt atgcctcctg tctctgcaat caaaggaata 30660

attgattcat ggttacttgc aaggctgctt tgaatttttt ttgctgtttt taaagacccg 30720

gtgaatgcaa ccccttttgat gttattaacc tttgaaagca tgtcaccatg aatgccgtct 30780

cctaggatta aatttaaagc atcttttggg accccaatct catgaaattt gttcacaatg 30840

atgtagccaa gaattgaagt atgttctgag ggcttaactg ttactttatt tccacatgca 30900

agggctgcac ttatttgccc tataagtatt gcaacaggaa agttccatgg actaatacat 30960

aaaatatggc cttttggtga gtaagatagg gcattgatct cgccggtggg accctcaaga 31020

atatggtctt ctgtttggag gccaacagct tgttttgcat agtatctgag aaaatctata 31080

gcttctctaa tttcatcaat agtattttgt actgtttttc cggcttcatt cataaggtaa 31140

taaattagct cagaaggatt tgcttcaatg tcgtctgcaa ttttttctaa aatggatgct 31200

ctttttttcaa catgcatcaa agaccattca ctaatatttt gttcttcaag gctgcccttt 31260

atataatcta gatcatcata tgaggctgta ccaatatttc ttccatctgc aagagatgag 31320

atgtcatgag tattggtttt cttataatcc tttgctttat aaatcgatga agcctttatt 31380

tcttttgaat caaactttcc aagctcctct tcaagcattt ctaaattcac cctttcactt 31440

aaatcaaatc ctttagagtt cggtctgtca ttaaatatat ttcttggcat tggtatctct 31500

ttttttttcat cctcaatttt taaatggggc cctctggcaa gccaagcaga atctgtttca 31560

ggatcaagta acctattaat aaatgagctg tttgctccat tttctaatag tcttcttaca 31620

agatagggta gcaagtcttt atatttgcca atcggcgcat aaattgaggt attttttttca 31680

gtatttaaga ttttgtttgc ggacttataa agcagctctc ccattccaaa tagtctttga 31740

aattcataat ccttatttga gccaagatga tggattgcag aaatggtatg tgcattatgt 31800

gtagcaaatt tagggtaaat tttttccaca ttaaaaattc tttttgcaca ggctaaataa 31860

gctaagtctg taacagattt ttttgtatag acaggataac catcatagcc atagatttga 31920

gcatgcttaa tttcataatc ccaatatgct ccttttacga gccgaacatg cataggtgct 31980

ctgttttcta gtagctcttc taaccaatct attgtggcta tagctctttt gccatatgcc 32040

tgaacagcaa taccaaatcc tttccagttt ttaatatttg gtgaaagggc catctcttta 32100

ataatctcta aactaacggc cagtctgtct tgctcctcag catcgattgt aatttctaca 32160

tctttagact ttgcatactc tgtgagctga ataagttttg gaagtagatc agactttatg 32220

tcttttagct ttttcatttc atatctagga gataaagctg atatttttat tgagacacca 32280

ttaattgtat tttttgtcag atttatcttg ccgacttcat ctatagcatt cttataagac 32340

tgataataag tgtcggcttg ttcagcgttt cttgctgcct ctccaagcat gtcaaatgaa 32400

taaatttcat tttctatatt cttaattttt tttatgtcat caaaatctct gcccataaca 32460

aattcttgac tgagaatatg catggcacca actacagcat ttctaattgg aaactcgcca 32520

gattttgaga ttaaagaact taatagggcg cttgggtttt tggtccactc atcgggtgta 32580

gaaactacct tgcctgcaag aagaagaccc catgttgatg cattaacgaa aacactatcc 32640

gctttgttta aatgctctat ccacgcaccc tcagataact tctcagatat tattagatcc 32700

cttgtttttt tgtctgggat tcttagtatt gattcggcta aacacatcag agcaacacct 32760

tctttattat ctagcccata ttcgcttaga aatgcatcta gttttgttct ctcgctctta 32820

ttctctctgc aagcatcaat tattttattg agcatttttt gaaatcgaag ggtcatttaa 32880

aaaatcagaa ttactaataa gatctgaaac tatttcttgt tcaggataaa acttgttact 32940

tgttaatgtc atagctatta ttttaatctt atagtgccaa gtatcaactt actgattcta 33000

ttaatgactt aaaaacatta tgatagtcat atgagtgatg cacttaaatt aattaaacga 33060

ggaaccgacg agatcctcac agagtctgat ttaaaaaaga aattagattc tggaaaacag 33120

ctaatcatta aggcggggtt tgatccaaca gctccagacc ttcatttggg tcataccgta 33180

ttattaaata agctaagaca ttttcaagat cttgggcata aagtaatttt tctaattggt 33240

gattttactg gtcaaattgg agatccctcc ggtaaaaata aaactaggcc aacacttact 33300

tcagaagaat taatttcaaa tgcaaaaaca tatgagaaac aagtttttaa aattcttaaa 33360

aaagaattaa cagaagttaa atttaattct gagtggtgca acaagcttgg tgcagatggt 33420

ttgattggtc ttgcatcaaa atataatgtt gcaagaatgc tggagcgtga tgattttaat 33480

aaacgttata gcgcaaatca aagcatagct attcatgaat ttttataccc ccttgttcaa 33540

ggatatgact ctgtagccct agaggctgat gtcgaatgcg gaggaacaga tcaaaaattt 33600

aatttgctag tagggagaga gctacaaaga tcctatggtc aagaacctca ggttgtttta 33660

actgtaccca ttctagaagg cttggacgga ataaataaaa tgtccaaatc attaaataac 33720

tttatagcaa tagatgaaga gcctaatgat atgttcggta aaataatgtc tatttcagac 33780

gagttaatgt ggagatggtt tgagttactc agctttacct cagagaaaga ataggagtt 33840

cttaagaaga aaatggaaga agggaccaac ccaagagata ttaagtttct tttagcagaa 33900

gagttagtag atagattcca ttcagagggt gatggttcga aatgcaagga agcttttctt 33960

caaagatttc aaaaaggtca aatgcctgat gacattcctt ccatgtcagt tgatgttggg 34020

gctgagggca ttccattagt aaacctttta aagaattgtg agatgacatc aagtacatct 34080

gaggcgatga gacttgttaa acaaggcgga gttaaaatcg actctgtaaa aatagaagat 34140

cctaaaatgc taatttcaaa aggccaggag tctatttatc aggttggcaa aagaaaattt 34200

ttaaaaatta aaacataatg aaaaataaat tagtccaaat atttcttctt ctttttatag 34260

ttgcgtgtaa tcaggatagc cctaatatta aacaaattag taatatgcag tattttattg 34320

ataatgaaat aagggaagga atctattctg ttgaaccagg cttgcaatac tcaattatcc 34380

aaaatggaga tcaaagttct gaatcaccat tgctgcagga tacaattaca gctcattttc 34440

```
acgggaccct cactgatggc tcagtttttt ggagttctgt tgaaatgggt gagcccttaa  34500
cagtcgaact atcaggtcta atagttgggt gccaaaaaat aatctctatg atgaagaaag  34560
gtgatgaatg gagagtttat atcgacccaa gtatggccta tggcgatgag ggccggcctg  34620
ggataccttc aaactcaatt cttatttttg atattgagtt attagatatc caaaaaaact  34680
aacccttatc tataacggat agagcgtatc cataaacctc agcaacctgg ttaataattt  34740
tatttttagg tgttccggct ccatgaccag ctcttccttc aattctaatt aatattggat  34800
tatcacaccc ctgggactct tgaagttttg ctgcaaactt gaatgaatga gagggtacta  34860
ctctatcatc tcttttagct gtagtaatca gagtagttgg atagcactca ccttcaacaa  34920
tattatgcag aggcgaataa gctaataagt tttcaaactc atctttctta tctggagagc  34980
catagtcact ttcccaggcc cagcctatag taaatttatg aaatctaagc atgtccaaga  35040
cgccaacttg tggaattgcg actttaaata aattaggatt ttgcaacatg gtcgcagcca  35100
ctagcaaacc tccattagag ccaccttgaa tagcggttga tgatggagaa ccaatttctt  35160
gtgcgtgtaa aaatttagca gaatatgcaa agtcatcaaa aacattttgt ttattaaaaa  35220
gcctgcctgc atcatgccag ttatcaccat attcaccacc acctcttaga ttaactacag  35280
```

caactattcc cccttggttc atccaagtga ggtagctttt actaaagcca ggtagtcttg 35340

agatattaaa gccaccatat ccatataaaa gtattggagt attactgtct atttttaagg 35400

acttttttgta actaagatgg atgggtattt gtgttccatc tttggatgga aagaatttaa 35460

agtcagatgt aaataaagtt gagtcgtgtc ctttaagatc ttctttccaa aaaagttctt 35520

gtgacatatc agttagatta attttgtata tttctcgagg agttacaaaa tttgtaaatg 35580

aaaaataaga tacctcatct tcaatttcac caccaaaacc acccattgtt ccttttcttt 35640

ctgttgctag cttattttta tatgctcctt ttaaatcaaa gaagtgaacc tcagtaaaag 35700

tatcaacgag ataagaaact acaatagaat tatttataaa gctaacacta ctaatagaat 35760

tagtactttc accaacgact tcattccaaa caaatgagcc atttttttatt gtaagtgata 35820

ctacttttcc gttcgcagca ttttcagttg agtaaaacca aaaagtatca ttcttgcttt 35880

ctaaaaagct ataagcgcct attagctcat ctattaaagg aataaaaggc tgatcagggc 35940

ttagctgaac atagagtcta tttctttcat ctgtgccttc accaatagat agaaacttaa 36000

ttttagaatc ttttacaaca cttattcccc aactccatct tggcttttca ggattctcat 36060

aaacaatcac atcctcatct tgagcagtac caattttatg aaacattaac tttggagctg 36120

tattaatatc ttttaaaagc tcttccgatg gctcgtcgta tttttggtaa taaaatccag 36180

aatcatcatt ttcccatgaa gcaccagaaa atttagccca ttcaatccta tcatcaagag 36240

tttttcctga ttcaatatca agtactttcc aggttctcca atcagaccca ccatctgata 36300

ttgagaaagc tagaagagat gcatcattac taacgctggt acttgcaaga gagatagttc 36360

catcttctga gaactgattt ggatcaagta aaactctatc ttggcattct tcacagtcct 36420

taatcatcag cttgctttgt tgccatgacc catcattgaa ataataaaaa gttttttttgt 36480

taacctgata aggcatgctt atcgaatctg tatcccaaac ctcatctaaa ttcttagcaa 36540

tagatttttt atatttattt tggcctataa atttttgtgt gaaattattt tgtctctcga 36600

cccagtctgt tgagtcctca cttgtaaaat cctccatcca tctataagca tcttcgatta 36660

ggtatccatg gacttcttca ctaaaaggaa ctttatttga ttcagggtat tcaaaattat 36720

ctgtttgatt tgagcaacta actagaatta atagagctgc catgtatatg tatttattgc 36780

gcataaaaag cataatactt tacaattacc ttatgaatca attcaatcga gcatggcaac 36840

ttttacgcaa aaaattggaa gtttttttatt gtacttgccg cacccatcat gatgcttgaa 36900

atagcaatgg catcaatggt aaccccaata caaaacgtta ctcagcctga ggatattcta 36960

gaatttttca atgagaatat agcctttcta ggctctgtta gtctcttagg cgtagtttta 37020

agtatggctt ttatgggagc gctttttgtt tcgtatgcat ccatagaatc agaaaatgag 37080

attgagcctc taaatgcctt atttttaggc ataagaaaat tctttccact tctgggggct 37140

tatcttatag cttcagttgg tgtctttttt ggtatcttat tattaatact cccagctttt 37200

tatgtagcag caaggctttg catttttcct gcatttatta tgcttgaaga caaaggagct 37260

atagaatctc ttaaattatc ttgggaaaag acggatgagc atggcaccac tttgtttggg 37320

cttaccatta ccttcttttc tttaacaatg atttttgcat cagttgccca atccattata 37380

agtccgggat taatgcaatt agttgttctt gcaattattg aatatgtaat agtaattcca 37440

tggggctatg tatattttag tttatacaag tcattaaaaa gatattaggc agattaacta 37500

gaataaatta atacgaagct tttcgtttac aaaaaaacac accactctta taatccttcc 37560

tccgaagatt tgcactttgt taattcatgc aaacaacttt gggtctgtag ctcagcttgg 37620

ttagagcgca cccctgataa gggtgaggtc ggtggttcga gtccacccag acccaccatt 37680

ctttgaacat taacttttat ttcctttata cttattctta actaaataag gatagtatta 37740

tggctaaagg tttagacaag caaaaaaacg acaagaagaa aggcaaaact ctaaaagaaa 37800

aaagagcggc aaaaaaagaa aaaaagaaat agtttttgt agaagactat tattatctag 37860

tcgacctagg gccatcttta aaatctattt taaagaacaa cattattccg gtcactgagc 37920

ttactaaagc taaaatagaa aatattttta aaagaaggtt gtcgatatta tctctttctt 37980

tccaatccat aatatgaaac ccccacatca gatcccatat tttccattta ttagatctaa 38040

tggccacaac ctctgctgag taaacattaa tgtaaacatt taattcagta cctttaacat 38100

ttttactttt tactctataa attggcaatg atctgcctct atattcagat cctgattttt 38160

catttacaac ttcttcggta gcaaatggca aaagagttgt ttggcttgaa actgaatcta 38220

tagcatcttc catagaaatc tttgttaaag gctgcccaag catattcaga tacttagttg 38280

agccctttgt tgtgatgata acaatctctt gacctaatct ttttttgaat ttaacttctt 38340

tagctttctc tatttcaaaa tttaacttac ttaaatcaaa agatgtttca acatgattaa 38400

ggtattgctc gcctcttacg agctcaatct tattaaaagc aaagtatatg cctgagatag 38460

tccaaagtaa taactgaaga gagataaaaa aacttaggta cttatgaatt ttcctaacta 38520

aaaagttcat cttttcataa tcttcattat ttcatcaatt tttacatcaa attcgtcatc 38580

acctttttaaa gattccttaa tgcattcacg caaatgggtt tttagaattt tgccctcaac 38640

agtaataatt gaattcttaa gtgcttttat ttgattaaga atatcaacgc agtattgacc 38700

ttcctcaacc attccttgaa cgcctcgcac ctggccctct attcttttta agcttattaa 38760

ttgctcttta tgacatggat gtttcatttt ataaaaacct cggaactata tacgtaaaaa 38820

ttgtagcgaa taaaaaaatt gctacagatg catagtacag atacctagat ttttttctag 38880

tttctgaaca tgctctgcct agttctgggt cagcagggca aggcatatga taagttttgt 38940

agttgatata tcctgcaatg acaatcatta ctaatgcaaa tagtgttatg taaagcttat 39000

attgagatag ggtaattaag aatggaaata cagttaccag gcttgcaaaa cttgccccag 39060

caccaagagc aacaaaaata gctggcaagg cacaacatat caaagtagaa gaagatgcaa 39120

ataatgaaaa aaaattcgac gccttatcat tcatagttat taaatttcta ggatttgaag 39180

atcagacata ttttggccat tagaaagaat cttcttttcg atctcagaga aggtgatttc 39240

ttttgcctta gaaaaggcaa tcactacttt tccattatca agatcaacat ctattctttt 39300

gacatcttta tcttttagaa aagtttttga aatacctctt gcacagaaat cacaaaccat 39360

tcccttcacg cttacgatcg ctatatttac atttgagagt ccttcaacaa atgcatcaaa 39420

cctctcaggg tttacatcaa gatcttttcc atcaaccatg gtttcatgta aatgaccttc 39480

atgagaatgc ccatgcatac cactatggtc attctccgcc gcaataaggc cgcttgaaag 39540

caaagtaatt aataataatt ttttcatatt tttctccttt taaaatctgt acataaaatg 39600

taaatcccag ctcgtatctg cgtcatagcc aaactcaaca agggcattac cataaaaaaa 39660

tttcaattct ggatacgtag atgatttatt tgttacagta ttttttttgg ttttaaccat 39720

aacccatgta tgtaaatcat tgtagtcagc aacgtaagga gcaaatccaa gttgaatata 39780

ttcttcttta tagtctttgc taaatttact gttaatatcc tttaacccaa agcccgcata 39840

ccacttccgg gtttcccagt ctccatggat accataaaaa ttatttttaa tacttccagg 39900

cacaattcct gattgaaaat ataaattcct ttgggatgta aaagtatttt ttctattcac 39960

caaataagta aaacgaaaat agttttctgt gttcttataa aatttatttt tagccctttc 40020

taggccaatg gaatatttgt aggttggaga gtagtggaaa taaatagaat cattaaaggt 40080

atctgattta tacattatgg ttgttccgcc agagtaggat atcggtcttg catcagcatt 40140

aaagaccatt aaaaaaacta aaatgattat tttatatata cccatggggg gtatcttacc 40200

ataggattat aaattaattt caggcatctc tccaagcgcc cattttcaat gaaatcacca 40260

tcagaattcc aaaaataacc atagctatag cagatgcata aaaaatacta actagcccat 40320

atgagagcca gtaaacagct accaatgcta taacagaaaa tactataagc ctgatggccg 40380

tgattataat tggccatttc attgcattgg ctccctgaga tgcaaaatac agggaaagcc 40440

catatccttg aaatacataa catacaccaa ggatttgaat atactgcttt gtaactaata 40500

aggtctctgg atccgatgta aaaatactaa tccaaagatt tggtgttagt gctaaagcta 40560

gaccgataac agccgaaagc aatccagctg ttgttgcacc aaccatgcct atttttctg 40620

ctcgctctat atttttggca cctatatttg ttccaaccat ggctgtcata gcagtcccaa 40680

tgccgaacac aattgggatt aataagaact ctacccttga accaattcca taaccggcaa 40740

tagcagacgt tccaaattga ccaatgagtc ctgtcagtaa aagaactgtt gcaactgtca 40800

ttattggcga aagagatgcg ggtaaggcaa cagaaaaaat atcttcgaat aattctcttt 40860

caattgttag tcttttgagc ttaagcctta caggcgatga agggctcgaa atttttatta 40920

aagttactaa tgccataaaa cctgaagtaa ctatcattga ccaagcagat cccacaagcc 40980

caagtttagg tagaccgaat gatcctaata taaatccagc agagaaaaaa acttgtatac 41040

ctgcacaaat taccgttagg actgcaggaa attgcatatc tcccatccct cttagggcgg 41100

cggttaagct acctgatagc caaacaacta ttgctcccaa taaatagaca aaacaataag 41160

ctaaagactc ctctaataat gcacctgttc cacctaatat tcttaataga ggctctccaa 41220

aaataaaaaa gataattaaa aaagctaaag ctccaaagca agatatatac aaagaatgcc 41280

ataataattt ttcagcccta ggcttgtctg cggctccaag acttcttgca atagaagatg 41340

tgaccgctcc tccaagagca ccaaatgcca tctgctgagt cagcatgatt gcaggaaatg 41400

ccaaagtaac agcagctaat ggagttatgc caagttgact aataaaccag aattcagcaa 41460

gaacaaccac agcatttatt aaaaatgcaa cagtattagg tgctgacatt ttaatcagca 41520

aaggaaatat tggatctttt aaaaattgct ctgttctctt gtccataacc ttctcattta 41580

ttaatattta tttggttaaa gggtgaaaga gaacacgttc tcaggattca cgaatcttta 41640

aataataata acagctttta gttaatttaa tttttaaaaa caaccaaatc tattatctgc 41700

tagattttat tttttaaaca tattaatatc taatttaatt gcaaaggggt ggccatttcg 41760

gcctgagatc cttggaaact ctttgaacct gatccataca ataatggcgg aggaattgca 41820

tgaaaatcat taaaaatcat ttatttttatt caataatctt actatatttt tttagtctag 41880

agacgagctc tcaagctata gaagaagtta ttatcaaagg agactggaga gaaactagtc 41940

tgtcagcaga agactcaagc attgcagtcc ttgatagtaa attaatagaa tcccaggctt 42000

taaagcactt tgaaaacctt tcgtacctag taccaaattt aaattttgct gcaagtgatt 42060

ctagagcaag acatttccag ataagaggaa ttggagaaag atctggctat gaaagaactc 42120

caaactctgc agtaggttta ctgattgatg atatagactt ttctgggcaa ggtggaattg 42180

ccacaacttt tgatgttgat caaattgaag ttcacagagg cccccaagga gcaagaatag 42240

ggtctagcgc aatggcgggg ctcatatata tttctacaaa agacccaaca gaaagctttg 42300

aagggaaggg tgaaatagtt atggggtcat atggaacttt taataccgga attgctgttg 42360

gcggtcctgt aaattttaat aaagacctca cttataggtt agctataaag aaagattatt 42420

ctgacggatt taggaagaat atttttctca acaagtctga tacttctaag aaagatgaga 42480

gcacatttag attaaaagtg aattgggtaa ctgataacca aaccacttat aagtttctta 42540

tatctcaaat agagttagat gatcctgcag atatatggac tatagatggg agtcttaata 42600

cattatctga taagcctgga atggactctc aaaaaagtaa tgcctatggg gtaaaaattt 42660

atcatcaatt taaaaaattt gaatttcaaa gcctatcaag cttaacgaat actgatgtca 42720

ttcttagtta tgatgctgat tggggcaacc ctgagtcgca ttcacccttt atttatgact 42780

atttttcaga aactacaaga aaaagagata cttttagtca agaatttaga cttgtatccc 42840

aatttgcaga taaaaataca gaaaaaagca tcgaatgggt cgttggggct agttttgtag 42900

atataaatga aacaaatgct aaaaaagata ctggtattta tggagatcca tcagacccat 42960

atggtcctta ttttagtaac tcttcttctt tgagtgactt ttcttcttca agctattctt 43020

tatttggaaa tattgattat ttaattaatg aaacaataaa aatttcaatt ggtggaagat 43080

gggagaattt taaatctaat tattttgatt cttatgacga atcattttca ccatcaaata 43140

aaatgtctgg tggtaagttg tcactagtta aaactcttaa taataattct aatatttatt 43200

ttaatattgc taagggctat aaccagggtg gatttaattt aggtcttggt cttgataaaa 43260

attcatcaaa tagaaattta tattatgatc cagaattttt aactaattac gaagttggaa 43320

ttaatagtaa atttttccag tcaaaattaa atcttggagc agtcctgttt tattctgatc 43380

gaaaagatca acaggtctta atttcaaccc aggttgatcc ttcagatccc aacacttttt 43440

tatacttaac ccaaaatgct gcagaaggaa ttaataatgg cttagagtta aatatagatt 43500

atgcactgaa taaatctcta ggtatatttg ctaattttgg attgctaaat acagaaataa 43560

aaaattggat ttcaagacca gatatagaag gtagagaaca ggcgcatgct ccaaaaaata 43620

gtttttcaat aggcatcaat tggaagccaa caaaccaatc ttatttatca ttgaatgttg 43680

ttggtaaaag tgagttctat tactctgatt cccataacaa tacttctgag tcatacaact 43740

taacaaacat taattatgga tatgaacatg gacaatggac ttattcatta tgggcaagaa 43800

atatttttga taagtactat tcagtaagag gtttttactt tggtaacgag gcacctgatt 43860

ttatagatac gctctacaga agacatggag atccaaggca tataggagtc atggtccaat 43920

atgatttcta actttataag tgaattttgg atggaaatag cagctgttgt atttgctatt 43980

atttatttat tacttgctgt aaaacaagac gtaaagtgtt ggtttgcggc tataattagc 44040

tcaatattat atttctttat tatgtatgac gcaggcttat atatggaagc ttacctgcaa 44100

atttttata tcatgatggc cttttatggg cttcaacagt ggagaagtgt cgatactgat 44160

gctcctcaat ttattgttag aacatgggat aaaaggatgc atattaagat cattacatta 44220

atagttatca tgactttaat ctctggattt ttattagaaa aatataccaa tgctatcttg 44280

cctttcatag atggactaac aacatgggga gcaatagttg cgacatatat ggttgccaaa 44340

agacttcttg aaaattggat atattggttt gttatagatt ttatttctat ctttttattc 44400

atgtccagag gacttttatt aacctcagga ttattcttta tttatcttgt aataatatat 44460

tttggttaca tgtcatgggt aaaaataaga gacgatatta gtgcagaatc ttcataacaa 44520

tctagatata aaaaatcata atctagagat tattaaaaca attaaatcag gccctgtatc 44580

tgaaatatct atttgtaatt ttgataacat caaagcaatc ttaagagttg atcatccatg 44640

cgcacacaaa ataaatgtag atcgagaaaa tgaaattttt atactcagcc aactaaaaat 44700

tttagatttt agtccagagg ttttatttag tgatttgtct tatggaattt tagtatggag 44760

atatatcgag ggtattgaat tttcacttgg taaggattcc aatgaagttt ttttaaaaac 44820

acttggaacc gaattaaaaa aaattcatga tattgatctc cccaaaagta agaaaaaata 44880

ttttagcaat gacataaatt tttacagaaa tttactaaag gaggttcctg aaaatataat 44940

tcttcataga ggatttgatt tatacgacaa actcaataac tctgataatt atgttctctc 45000

tcataatgac ttgaataaga caaaccttct ttggagggat aggttatttt ttttagactg 45060

ggagtactcg agttttaaca atccttttt tgatattgcc tcgttatcga atgcttataa 45120

cttatcaaaa gttgataggg caattttatg gaaagcttat acaaataatg aatattcagt 45180

attaaatgat acaaatctta gagaatggat gcatttttgt cattatttag agtacatgtg 45240

gagtatttcg ctcatacaaa atggaaaaat tgatcagaac accctaaatt taaaaaaatt 45300

agagaaaaaa ttaaaaaata ttatttaaac aacaagtatt gcgcattctt tagttgttgt 45360

tttactatta tgtaagaaat ttacatttaa atgggggttt gatatgaaaa ttttatgtgt 45420

cttatatgat gatccaaaaa caggtatgcc agaaaggtat gcaagagatg atttaccaaa 45480

gttagataag tatcctgatg gaatgacact tccatcccca aaatctatag attttactcc 45540

tggtgagtta cttggttgtg tatctggaga actagggctt cgaaagtttc ttgaagatgc 45600

tggccataca ctagttgtta cttctgataa ggatggagat ggatgtgagg ctgataaaga 45660

attagtagat gctgatattg ttatatcaca acctttcttc ccatattatt taacaagaga 45720

caagatgaaa acagcgccta atttaaaaat ggcaattaca gctggcattg ggtctgatca 45780

tgttgatctt caggcagcca tggataatag cgtggatgtt gttgaagtta cttactgtaa 45840

ttctcgttca gtcgccgaac acattgtgat gatgatccta tcgatggttc gtgattatca 45900

tacccaacat agaattgtaa aagagggagg atggaatata gctgatgctg tacaaaggtc 45960

atatgatgta gagggcatgc atgttggtac tgtagctgca ggtagaattg gtattgatat 46020

gctaagaaaa atgaaaccct ttgatgtgca tttgcattac tttgatattc ataaactctc 46080

tgatgaaata gaagcagaac taaacctcac ctatcatgat tctgtagagt cattagttgc 46140

tgtgtgtgat gtagttaata ttagttgccc attgcatcct aaaactgagc acttattcga 46200

tgatgaaatg attagtaaaa tgaaaagagg tgcatatatc atcaatactg ctcgtggcaa 46260

gatttgtgat aaagatgcta ttgcaagagg cttagagtca ggccagctaa gtggttatgc 46320

tggtgatgtt tggttcccac aaccagctcc aaatgatcac gtatggagaa caatgcctaa 46380

ccacggcatg actcctcata cttcaggtac ttcgctatct gctcaaacaa gatatgccgc 46440

tggggttaga gaaattctag aatgttattt tgcaggcgaa ccaattagag acccatattt 46500

gattgttcaa aatggtgatc ttgcaggtat gggtgcgcac tcgtacacaa agggtacagc 46560

cacagatggc tcagaagagg ccgctaagta taaaaaataa gttttagaac ttacttagcc 46620

tttccttaat aatagagtct gcctctgcca taatgctatg cattaattct tccactgtcg 46680

ggatgtcatt aaccagtcca gcaaccattc cacatgacca ggctccaacc tccatagttc 46740

cttcatgcat aatttttgga tagactcctg caacctcatc cacaatatca gcaaaagtta 46800

attcatcacc aagagctttt tctttttcaa tcaatctctc aacagcttca ttattaagaa 46860

ccctttctgt atttgttaat gatctcatga tgagtctagt atctaactca gaagcattta 46920

cgatagcctc tttcacattt tgatgaacag gtgcatcttg agtagcaata aacctagttc 46980

ccatattcat tccctcagca cctagtgaca tggcagcaac caaacttctt ccatctgcca 47040

ttccacccga ggcaacaaat ggtatttcaa gctcatctgc tgctctaggt aagagtatga 47100

aattaggaat gtcatcttct cctgggtgtc cgccacactc aaaaccatct acagaaaccg 47160

catcgcaacc tattgcttgt gcttttaatg agtgccttac agaggtgcat ttatgaataa 47220

cttttattcc tgcttctttt aaagctggga ggtattctgc aggatttctt ccagcagtct 47280

ctacaacagg aacccctgca tcaataatta cttttatcaa accaggatag tctgggggtg 47340

ttagtgatgg taaaaatgtt aaattaacag caaatggctt attggtcatt tctttgcatc 47400

tggcaatttc atttgctaat ttctcaggcg taccctgtgt tagaccagta attgttccaa 47460

gtccacccgc atttgatact gccgctgcaa gctcggcaaa accaacatgg tgcattccac 47520

cttgaatgat tggatgttct ataccaaata attcagttat tttagttttc ataatactct 47580

cctatttatc ttccattggg gttaaaaaat cttcatattg agtttgaagt ctttgcatgc 47640

cacttatcca tctatctctg tcattacctt ttcttttaac atattctaga acctcactat 47700

gaggggttac taaaaacctc tcctcctcta tggcgttaag aacatccttt gcaacaatat 47760

cagcttccat cattccatca actcctgcta caccaggacc atttgcagtc atagcagttc 47820

taactgcttg agggcataaa caggaaacgc cgataccttt atttccatat gtaattttta 47880

tccattcagc aaaactcaca gctgcagctt ttgtaactgc atatccagcc gcacctagtt 47940

gagttaaaag accggctgct gaggatgtat tcataagata gccttcacct tgttctatca 48000

tttgaggaag cacatgtttt gcagcatgaa tatgagactg aacatttaca ccccatatca 48060

tgtcccaatc cgaagtatct gcttcaaaaa atcctggctt tccaccgata cctgcatttg 48120

aacaaaatat atcaatacca ccagaaaatt cattagcctt ttgtataaca tttataatgt 48180

cgttttcttt ggaaacatca gcacttactg caagcccatt aacactcttg gctgtttcct 48240

ccgccccatt taaattcata tcaacacata ctatagaact tgccccagat gcatagaact 48300

cttcacataa agccttacca attccactgg cagcccctgt aaccacaact cttttattat 48360

taattttcat aaattgacca ctttttttaat ttttattta actttattgc ttagatagtt 48420

tattacaaaa caacaatact taatattgca aaatcgcata cccatcttta taaatttatt 48480

gctattatta gtgctagaaa atgaaatact gagatttaat atgaagaatg ttgttgttat 48540

tggctcgtcc ggggcaatag gaaaagcctt tattgatagc tatatcaaag atgatgatgt 48600

tgaaaatata ttttcatttt caagaacagg cctttccatt gaggataaaa aactccatag 48660

ttttttttatt gatattgagg atgaaactag tatttgtgat gccgcagaga agatagacaa 48720

gtcctcaata gatgaaatta tcgtcgcaag tggaatactt cataataaag attttgggcc 48780

agaaaaaagt attagagatt taaatgcaga taacctttta aaggtcatta aggttaatac 48840

tatcggccca acaattgttg gaaagtattt cattccattg ctaaataaaa aagaaaaaag 48900

cgtcttagca tttttaagtg caagagtcgg cagcatttct gataataaaa caggtggttg 48960

gtatgcctat agagcgagta aaactgcact taatcaaatc attaaaagtt ttagtattga 49020

attacgaaga accaatccaa atgccattat ttttggtcta cagccaggaa cagtagatag 49080

tgaattaagc gaacctttta aaagaaatgt aaaagaaggt aatttattta ctccagaata 49140

tagtgtattg cagctaaaaa atattattga tacagcaagt ccatctgatt caggcaaact 49200

aatttcttgg gatggggaag agattcagcc atagttggtt atgaatatat tttcatatta 49260

gaataaattt ttaggggaaa aaatgagtat taaatattat gactggtcta aatttcaggc 49320

caacactagg ccaaataaag ttgccataag agagctagat aataacaaga tctatactta 49380

cggagaattg gataaaagat catcaaggct tgcatcacat ctccaaagtt caggaataaa 49440

aaaaggagat cgtattgcga tactatcgct aaattgttca gaatttttg agctagaatt 49500

tgcttgcgga aagattgggg caatagagat accattaaat tggagattaa caaaacccga 49560

gctcagttat attcttaatg atagtgagcc aaaaactcta atttatgaca atcagtttga 49620

agaaatggtg aaagagctaa aagaagaatg taatatttct gaaatcatag ctcttgatca 49680

atttgaccaa gaaagtgatt atgaaaaagt tttgagtaat gcttcaggca tttattatca 49740

ggaagaagtt gatctagaag ataacattat gattatgtat acctctggaa caaccggtca 49800

ccctaagggc gccatgatca cgcacaaaat gcagcttttt aatgttatta atttaggtat 49860

ttcagcagct gtttcccctg aatcagtcca tttagttgtc cttcctttat ttcatacagg 49920

cggaatgaat tgttattcaa atccaattct tcatgcaggt ggcgagttaa tattacttaa 49980

agagtttgag cctgggaaag ttctatcaat tatcggcagc tctgactatg gagttactca 50040

tctgtttgca gttccagccc cttatcaatt tatgatgaat catccagatt ttgaatcaac 50100

aaatttatca ggagttaagt atgctggagt tgggggcgca ccttgtgcag aggctatttt 50160

gaagacttat ataagcaagg gtgtttcgat gcagcaagga tggggtatga cagaaactag 50220

tccaggtgct actggtcttg aatcgtccga ggctgaaaga aaaataggat ctgctggaaa 50280

accgcttctt catactgagg tcaaggtggt tggagatgat gggaatgaac tgcctgctgg 50340

agaagtaggc gagatttata ttaaaggccc aaatattaca cctggctatt ggaagaaaga 50400

agaggctact agagattctt ttgaagacgg gtggttaaaa acaggtgatg ctgcttactt 50460

tgatgacgag ggtttttttat acatagttga tcgatggaag gatatgtata tctcaggtgg 50520

agaaaatgtt tatccagctg aagttsaaaa tgttatctat cagttaccac aaatcgcaga 50580

agttggagtt attggtattg atagccctaa gtggggtgag actggtaaag cctttgttgc 50640

tttaaagccc gatcatgaat tgacggcaga agaagtcata gatcattgtt taaaaaatct 50700

agcaaagtac aaaattccag agaaagttga gtttattgca gctcttccaa gaaatgctac 50760

aggtaaagtt ttaaaaagaa cattaagaga tatgtaatat ttttaagcca aaaaaaaccc 50820

agcctaagct gggtttttta tttaactatt taaagttatc taatgttaag cattagaaga 50880

ttctttaaca gcaacattcc atataattaa accaaataga atcttgttaa caaagtcagc 50940

aaggttatag ataaggttta agttaagagc tgatccaccg tcacccatca ggtaacctgt 51000

gaaataacct acaggataaa tcgcccaacc aaagatgata atatacatca ttgtgttgta 51060

agctgattgc acagcaggac ttgcagtatt acatgcagat tttccttctc cagcccataa 51120

ttcataaatc atgtataccc aagctaaaca cccaataatg aatgcaggcc atgcagccat 51180

gattcctgct tcacccatgt aaccaaacac aagcataaca agagaaccaa ctagtaattt 51240

cttaaataat gatccagcaa cattagttgc agcagcaaga attaagtaga attcacatat 51300

taatagagga actgttagta accaatcaat gtatctaaat acagttggcg aatcaccagt 51360

ttcaatccat acccctctca tgtacatgta atgccagaaa gcaataccag taacaagacc 51420

agatacagtt aatgatgttt tccattttgc agaaactcta tctctttcaa caaagaaaaa 51480

tacagtagat gctaataaag cagcagtaac taaccaaaaa gaaacaccag tgtaatcact 51540

agcatcaagg tcaccaccac ctgcagcaaa tgtaggaagt gcaataacac tacctaatat 51600

cagtaataat ttcatatata actcctatat taatgacaaa gaagcataat tgcctccccc 51660

ctaattaaat atgaaattta atagtaacca atattaatag aggttacaaa taaaaagcat 51720

ctatttttt aatagaaaat atgtgtaata aaacaccata ctttaaatta atatttattt 51780

tgcataagta gacttgttta gtatcatatt taacatgaaa gttgcaattt atcctggttc 51840

ctttgacccc atcacaaatg gtcacacgga tattattgat aggggttgcg gactctttga 51900

caaggttgtt gttgcaatag ctaagagtga atcgaaaaac cctcttttta gcctagagga 51960

tagaattaat ttagcccaat ctatttttaa aggaaatgaa aaagtagagg ttgttggttt 52020

tccaagaaag ttaacagttg atcttgcaaa agactatgga gcttgtgcaa ttataagagg 52080

cctacgagca gtttctgatt ttgaatatga atttcagtta gcaacaatga ataggtcgct 52140

ggctcccaat attgaaagca ttttttttaac accaaaagaa agtctcattt atgtatcttc 52200

tagcttaatt aaagaaatat cagacttaaa aggcgatata tcgaagtttg ttcatcctat 52260

agtagagcag gcacttcgag cgagtagaca cttagctctg acaagcttca caaaaaaaag 52320

tagctctttg attgacgatc gttttacaaa tagtgccttt gcatttattg cagggctcgc 52380

cttctcttcc atatacattt aatttaaatt taaaatatcc tggactacca tcagctgagt 52440

agaagtcttt taatgtagtt cctccaacct ctattgcttg ctctagtatc ttttttccag 52500

cagctactaa tcttttacaa gcatctaaat ctaactcatt ggcatttttt agcggatgaa 52560

ttttagctaa gaaaaggctt tcagacgcat aaatattgcc gataccgact acatttttt 52620

gattcattaa atagctttta atatttgttt tagagtgact gcatcctgaa aaaaaatcct 52680

ttgcattaaa atttttagaa agaggttcag gcccaaggtt ttttattaac ttatgtttat 52740

cgatatcaga agtaagatgc attgatccaa accttctggg atcattataa ataattcttt 52800

cctcatcaaa aattaattca atatgatcat gtttgataaa gaagttttca ttatttttg 52860

caattctaag actcccagac attcctaaat gaagaataat ttttttatca ttagatagtt 52920

taaaaattat atattttgct cttctttcta agctttcgac aacttgatct tttactgagg 52980

tttcaaagct atccaccact ttccatctaa ggtttctgtt gtgtatcctt gcttctttca 53040

gcaaagagcc tttaaatttt ttaattgctc tcagggttgt ttcaacctct ggaagttcag 53100

gcatttttaa ctgagtaaat tattaatttt tactatgtca gctggagtaa ttgttcccga 53160

tgcgagccct agtcttagat tggcaagtat gtaatcatat tttgcattag caagattttt 53220

ttccgcgctg tataagtttt tttctgcctg caagagatca acaacgtttc ttgttccaac 53280

tctgtagcca acttgagtcg cttccagggc actagtggcc gaaatcactg cttgtttttg 53340

agcatttaca tttgcaacta atgttaaaac atttgaaaac tgggatctga cttcttgaat 53400

aatccttctt tctgtaaata gagtattttc atttgctctt tcatactgtg aatatgcttg 53460

cttccttctt gagttaacgg cgccgccttg aaagagtggc atacttagct gaattgcata 53520

attccttctt cctgttactg atggaactgg aataccttgg ccattgatat taaaaccttc 53580

atagttaaat tggtttgttt cagattctga ctgacttcca acaatgtcta tcttaggtaa 53640

atgatttgaa gctacacttc ttgcactgct tttcgctgct ttctttctca aatatgctgc 53700

ttttaactgg tagttatttt ccaatgctaa ttcaacccat gtctcttttg aacttggtgt 53760

tggcaggtca ataagcaaac catctcccaa ttcatttaag ctgaatattt ctctaccaat 53820

cagagcattt aaagactctc ttgcagaata aagtgatcct tctgttctaa ttcttgaggc 53880

tttacttaga tcaaatgcca attgagcctc ttgaactcca gttatggctg ataacccaac 53940

atcgaatctt tgttttgctt gatcaagttg ttttttaata gctttttctt cagatattgc 54000

tgcatttaga ttatcaatag ctctaagtac gccaaaataa agctcagcag ttcttactaa 54060

aagattttgc tgctcaaatg caaagtctgc ttcagcagca tctgtaagag atttagattg 54120

cctatattga aaccatgtat ctagtctaaa gagcggctga gtaaccctgg cagatgtaga 54180

aaaagagtta tattgctgct gcagttcttt gttttgatag tattcgttcc agttagttga 54240

tccactcaag gtaatactcg ggagaagcgc agctcttcct tgaaccttaa gctctttatc 54300

tgctaaatat gaatattccg ctgctttata tgtagggtca ttctcaagcg cttcattata 54360

gatatccaaa agactttcag atgaaatatt aaatgagata aaaagtgcta aaaatgattt 54420

tgtgtaaatt ttcataactt attttaacct attaataatg tttgcagtgc aaacatttat 54480

ttttttttaat tttattgaat ttatttttata tttcttagag tagaatatct ctaacaagtt 54540

caataatttt ttataataaa aaggctttaa aaattggcta aaaattcata tgacgctcag 54600

gcaattgaag tcttatctgg actagatcct gtcaaaaaaa gacctgggat gtatacggat 54660

acatctaacc caaatcattt aattcaagaa gttcttgata attcggttga tgaagctctt 54720

tcaggttatt gttcaaacat aaaagtatct gttctaaaag atggctttat taaggtctct 54780

gatgatggaa ggggtatgcc aattgatgag cacccggaac ataaagtttc aggtgttgag 54840

ctcatccttt gtaaacttca tgctggagcg aaattctctg gagatgatta taatttctct 54900

ggtggccttc atggtgttgg agtttctgtt gtaaatgccc tatctgatga attagaggtt 54960

agagtaaaaa gagattctaa agaataccaa atcactttta ataatggaga taagtcttct 55020

gaattaaagc caattgggga agtggggctc agaaattctg ggacatcaat taaattcaaa 55080

ccaaatccta catattttga aactatagag attcagataa aacagcttaa gcatttatta 55140

aaggccaaag cagttctctg tcctggatta acgatagagt tcgttaatga aaaaaagact 55200

gatgataaac aaaagtggta ttttgaagat gggctcaaaa gctatttgat tgattcttcc 55260

gagggagcag acttggtttt gctagattca attgtatgct ctaaaaaatc tcaagctcaa 55320

gagcttgaat ttgcaatcaa ttggtcatta agacccccaa aaaataaact cgatgaaacc 55380

tatgtgaatc tcataccaac tgctcagggt ggctcacatt taaatggctt taaggctggg 55440

ctttagatt cattaaaaga attttgtgaa tacagaaatc tattgcctaa aggtttaaaa 55500

attaatgcag atgatgttct taataatgca atttttataa tttcatctaa gcttcagaat 55560

cctcaatttg cagggcaaac caaggaaaga ctagattcaa aagatcacat gtcgttcgtc 55620

tcaagtacca caaaagacat tttaagtatt tggcttaaca ctcatacaga agagggcgaa 55680

agaatagcag aacttgcaat tatgtctgct cagacgagag caaaagtttc caatatagtt 55740

gaaagaaaga aaacttttag aggcccagcc ttacctggaa aactttcgga ctgtaatagt 55800

caggacttaa atgaaacaga gctttttta gttgaggggg actcagccgg agggtccgca 55860

aaacaagcaa gagaaagatc tttccaggca atcatgcctt tgagagggaa gattttaaat 55920

acttgggact tagaaagtgc agaaataata aaatctcagg agataaaaaa cctatcaact 55980

gcaattgggg ttctgccagg aaataatgac ctttcatcac taagatacgg aaaaatttgt 56040

attcttgcag atgctgattc agatggtctg catattgcaa ctttactttg tgcattgttt 56100

ctaaggcatt ataaatcttt agttcaagag ggaaggatat atatttcaat gcctcctcta 56160

tatagaatcg attctggtaa agatgttcta tatgcacttg atgataaaca gcgagatgaa 56220

atagttactg aatttaaaaa gaagaagggc aagcctaaag taaacattca aaggtttaaa 56280

ggacttggtg aaatgaatcc acctcaacta agagagactg tgatggaccc tgctactcgt 56340

cagcttgttc agctttctat cagctcaagc gataatgcaa attctatgat ggacttactt 56400

ttgtccaaaa agaacgcacc agcaagaaaa gaatggcttg aaaagaaagg gtctctagca 56460

aaaatataaa tatgaaagaa caaataacct caattagcct caagcaatat gctgaagagt 56520

cttatcttaa ctatgcaatg tatgtcattt tagatagagc tttgcctaat attggagatg 56580

gccttaagcc tgttcaaaga agaatactct atgcaatgtc agagcttggg cttgatgctg 56640

gctcaaagta caaaaaatca gcaagaactg ttggagatgt tataggaaaa tttcatcccc 56700

atggagacgg cgctgcatat gaagctatgg ttttaatggc tcaaaatttc tcattcaaat 56760

acccttttgt agatggtcaa ggtaactggg gttctcagga tgatccaaaa tcttttgctg 56820

caatgaggta tacagaatct aagttaacta aatttgcaaa tcttttaatc tctgaattga 56880

agtctggaac agtcgattgg cagcctaatt ttgatggctc tcttttagag ccagtaattt 56940

ttccagccaa actcccatct attttattga atggcacttc tggaattgct gtaggaatgg 57000

caacagatat tccatctcat aatattaatg aaattattga tgccacagta catcttattg 57060

ataatccaaa atcacagttg gttgatttac tcaagataat taatggtcct gatttctcaa 57120

ataattcgcc aataattgct agcaaagatg agctgaatga aatttattcg actggaaaag 57180

gcggcttcaa agctcaagcc caatgggcgc aggataagaa tcaaatcatt atcaacgcat 57240

taccttatca agcatctggg tctaaaattt tagagcaaat agctgatcaa atgcttaaga 57300

aaaaaattcc aatggtggtt gatcttactg atgaaggaga ccacaaggag ccagtaaggc 57360

ttgtcataac tttaaaatcg aacagagtaa atgctgaaga tgtaatgaat caccttttg 57420

catcaactga tttacaaaaa aattatagag taaatatgaa tttgatttca ttgaaaggtg 57480

gaccaaaagt tttctcccta gttgatttat tgaaagaatg gctagtcttt agaaaagaaa 57540

ctgtaataag aaaactagaa catagactcg accaggtaaa cgataggctg catatccttg 57600

aggggttatt aattgtttat ttagatttag ataaagtaat aaagattatt agagaatcag 57660

atgagccaaa aaaagatatt attacagctt ttaaactttc tgatatccag gcaaatgcaa 57720

tccttgagat taggttaagg caactagcca agctagaaca aatcaagtta gaacaagaaa 57780

gagatacttt ggtagcagaa caaacagata ttgaaaaaat actaagctct aagacaagac 57840

ttaaaacatt aattaaaaat gagcttattg aaataaaaga tgagtttgga gaagtaagam 57900

aatctccaat aagagaagca acagaagcca aagtttttc tgaagaagaa actcttgtca 57960

ctgagcctat tacagtagtc ttgtctgcag ctggctggat cagaagtgca aaaggccatg 58020

agatagaccc cagctcactt tcctatagag gagaagatgt acttcaagat tatggaagag 58080

gaaagagcaa tcaagtttca gtttttcttg actcaaatgg gaaggcttac tcacttgcaa 58140

gtcactctct tccatctgct agaggaatgg gtgatcctat tacaggaagg gtatctgcag 58200

attctggagt aaagttcatt tcttcattga ttgggaatga tgaagataaa ttcatgatta 58260

tgaatactgc tggatatggc tatatttcag agtttaaaaa tatggtttct aataagaaat 58320

caggaaaagc atttatgaaa atccctcatg aagcagacct tcttaaagcc attaaagtaa 58380

gagacgatca tttgtatata gcagcagttt caaatattgg cagactttta atttttaaga 58440

ttgatgaatt gccaactctt ggaaagggca aagggaataa aataataaat ataccaaccg 58500

ctaaatttat agcaaaagaa gagttaatga cccatgcgca acttgtttct gaggctagct 58560

ctttaaggat tgaaagcgga aagagattcc tcactttaaa actcaaagat ctagaaaact 58620

atatttctac aagagcaaaa aggggaaata tgcttccaca aggatatagg aaggtagata 58680

aaatgattga agaggttgag ttagaagtta aagaagactg attatagatt tctcaaaaat 58740

ttttaatccc tcatcaacta gctcattttc tattattagg cttggagaaa acctaacagt 58800

agatgcattc gccttaagaa tcattaaccc attatgatgg gatttttta ttaaatcatc 58860

tatttgaatt ttgctatcct tgcttacttc cactccgacc cataaaccag cagaagttat 58920

tttttcaaaa catttgtgct tctcatttat tttattcaac aaattgataa atctaacttc 58980

tttctttaaa accttattta aaaatgattt tttagaaatg gtatctataa cttcattacc 59040

tatggcacat gcaattgggc ctcctccaaa agtcgtgcca tgagaccctg ccgacatatg 59100

ttttgaaact ttatctgaag taagaatgcc tcctagtggg aagccattag atataccttt 59160

agcaaaacaa agaatatcag gagtaatgtt aaattgctca taagcaaaga gtgttccagt 59220

cctgccaatc ccggattgaa cttcatcaat tatgacaagt gccttatgtt tttttgcaag 59280

tttctttatt tttgctataa attttttatc tgcttttgtt attccagatt gccattgaac 59340

cagttctaat ataaccgctg cagtcttatc tgaaaaaacc ttttctagat tagtaatgtc 59400

attatatgga tgatttttta tccctctagg cagaggcgca aaaccgtctg taagatgctt 59460

agctttagct aaagctatac caagcatagt tcttccatga aatgacgttg aaaatgaaat 59520

gacctcattt ttatttttat taactgttga tgagcaaaat tttcttgcta tcttaactgc 59580

agcctcaatt gattctgccc ctgaattgca aaaaaatact ttatctgcaa aagaattctt 59640

gcataacttt cttgccaaag taactgaggg ctcatttatg tagagatttg ataaatgcca 59700

aagctcctca gattgctttt taagaatttt tattagatct ttatttgaat gaccaaggtt 59760

agtgacggca atgcctgctg tgaaatcaat atatttctta ttatttaggt cccatacatg 59820

cgatccactc gctttttta caacaaaatc tgcaggagcg taaaaaggca ccatataatt 59880

agtatattct ttaattatct ctttcataaa tatattgtat cgtggtttca gttcaaaaat 59940

taaatgacca aaaatttcta gtatctttaa aaccaaacag ctcactcatt ggctttaata 60000

gaataatatt tatatctagt atatctattg tatgcggtgg catagcattg atatttttct 60060

tttttggagc aacgctcatt ttgcctttg ctggtttaga gcttggtatt ctattcactg 60120

cattctattt aagttttaaa tggagtgata aaaaagaaaa aatatttatt tctcaagatc 60180

ttgtaactat agaaaaaggc tctaattatg ctgaatataa atgggaagag ttcaggtcat 60240

ttacctcttt ccaggtttca aaagacagaa gagatcttct taagctaagc tttaggtcta 60300

aaggcgagga tgttgaggtt ggcagctttc taaatgaaga tgataaaaat gtattaatag 60360

aagagctaac tcagatcata gatacattaa atcacgattc cttctcaaag ccagagcttt 60420

aatttctttt taacttcttt tagctttaat tcttttattt cagggatgcc atttctaaaa 60480

tttggaaatg attctccctg tattaatggc ataagatatg caattgcttt tggggtaacg 60540

tccattccat ttttagctat aaaagatttt ggtaattttt tttctaaatt agctattttt 60600

gccagtggag ctggttcaat tttccaccta tatttttag ctttacctct aactattatg 60660

ggcataacac cattcatgcc ttctactgca tactgaactg ccttggcccc aacagccata 60720

gcttgctcta ggtctgtttt ggaggcaata tgtcgtgcac ttctttgtag atagtcagaa 60780

acagcccaat gatttttag ttttaattta tcagtaatta agttggcaat gtaaggcgca 60840

actccaccaa gttgagcatg accaaatgca tctattgttg ctgattcaga aagaaatctg 60900

ttcttattat ttttcaaccc ttcggatacc acaacaacac agtagccatt ttttttaaca 60960

acacttttaa cttctgctag aaatttttt tgattgaagg ttatttcagg taataaaatt 61020

atatgaggtg catctccttt ttcttttctt gcaagagaag atgcagccgc catccagcca 61080

gcatgcctgc ccataacttc taatataaaa acttttgttg atgttgctgc cattgaccga 61140

acatctaatg aggcttctag agttgatgtt gctatatatt tagccgccga cccaaatcca 61200

ggacaacagt ctgttaatac caaatcgtta tcaacagttt ttgggatggc tatacagtta 61260

attggataat ttaatttttt acttatctgc gaaactttaa atgcagtatc agctgaatca 61320

ttaccgccat tgtaaaaaaa atatcctata ttgtgcgctt taaaaacatc aataagcctt 61380

ttgtactctc tttcgcttga ctcaagatct tttaacttaa acctacatga cccaaaagcc 61440

ccaccaggcc tatatttcaa tgactctaat gcagatattg attcttttga tgtatctatt 61500

agttcctcat tcagcgcgcc caatattcca ttcttgcctg cataaatttt accgatgtct 61560

ttatgcttct tggcctctaa aatcagagcg ccagctgtag catttataac tgcggtaacg 61620

ccgccggatt gagcataaaa cgcatttttt ttcatttttt ctccatcaaa tgtactgaaa 61680

taaaaatatg taaagtatta taactaatat gcgaatacat atcttaggga tctgtggrac 61740

ctttatgggc ggccttgcta agatacttaa agagtcaggg catgaaatat ctggatcaga 61800

tattcaattt tatcctccca tgtcagacta tcttgatagc tttgatattg aaatgatcaa 61860

gggctatgac ataaaaagca tgccagatgc tgacttgtat gtgattggta atgcactttc 61920

tagaggaaat gaatccgttg agcatatttt gtccaattct cttccgttta agtcaggccc 61980

tgaaatgctt ggagaaattt taaaaaataa aaaggtttta gctatatctg gaacacatgg 62040

taaaacaacg acttcatata tgttgactca tattatgtta gatcagggta gggatgtcgg 62100

ttttctagtt ggtggaatat caaataatat atctggctct gcatgtcttg ggtcagatgg 62160

aacttttgtg attgaggcag atgaatatga ttctgcattt tttgataaaa gatcaaaatt 62220

tattcactat tcaccaagca ctatagtcat caataatatc gaatttgatc atgctgatat 62280

ttttaataat ttagatgaca ttaaaagaca attccatcat ctaattaaaa taattccatc 62340

aaatggaaat gttgtttatt ttgctgatga taaaaatata agagatctta tcgatatggg 62400

aatttggtca aatcagatag caatcaataa taatgctcat tcaattgagg cagtttattc 62460

tgataagact ctaaaatatg aagaaagtat ttattcatta aatgagttac ctttaatagg 62520

agaacataat tttaaaaact acatttcggc tattttggcg gcaaagacag atggaattca 62580

aattcaggat tctatcaaat cattagctag ctttgatggc gtaaaaagaa gattagaata 62640

taaaggaagt tttgatggca tagaaattta tgatgatttt gctcatcatc caaccgcaat 62700

agaattttct tctaatgccc tcgtaacaca aaatccatca aaaaaaatac ttggtctcat 62760

tgagctaggc tcaaacacta tgtctggggg ttctcatggc ttgtctttgg ttgaatctgc 62820

aaaatcttta actcatgtta tctggctaga tcgcaataat gttttgtcag agaatgctag 62880

cattgaatct actaacacta ctgaagattt tatttctgca gcgatatctg ctttctcaga 62940

ttatgatatt gttattttga tgaccaataa agacagccaa aaaatattaa aacccattgt 63000

agatcacttt gaaaaataat aatttaccag tttttccttt aggaatagtc gccctcccag 63060

gtagcatcca atctcttcaa atttttgagc ctaggtatat acagatggtt aaaacatgtc 63120

tatccaagaa ccatggattt gtaattgttt ttaatgccaa taatgagtct caaggcgatt 63180

tcacttttttc taagaaggga agttttgttg aaattataga ctttaataat ttgccaaatg 63240

gccttcttgg gataactgta aaatctataa ataaggtgat aatcagtaat atatgtcaat 63300

tagaagatgg actgcatatt gctgatatta aggcacagat agatccagag gtagatgatc 63360

aagctgtttt ggcagaatat cctgagatat ctagcattct ttctcagctt gtaaagcatc 63420

ctaagattag tgacctgccc atccaggttg actttggctc tgctgattca gttgcatacc 63480

acttagcagg ccttatacct ctaagctcaa atgagaaaca aaaactatta gaagcattcg 63540

atgcagcaca gcggatgaga attctttcag actatattga aagaatatct actacataaa 63600

ttatttattt taatattatt ggcggcttat tagattttgc tctaagccaa ttgatggact 63660

taaaaaccgt agggatttct acaaaccttt tttcaatata gtatttgcct ggatagttac 63720

taagcattag cccaataata atagtgaaca aacctggcca ggtaacacca gcatcatgat 63780

tcccccaata ataagggaat aacctaaaat atttttaatc agtaaaacta aataccacaa 63840

caacgggtta ttggtcttaa atttcgagac atctttcttt ataaaatagt cacttggaat 63900

taatccagca agccacctca tactaacgag actaaataaa aaaataaata aagatattga 63960

gctcagccaa agtataagaa ctttataaga ttcaaaaaaa attatgatgg catttagggt 64020

attaaattcc ataattaccc acctttttat ttaataatga tttagtatag caatgtctaa 64080

aaataaattt aaacattaaa taaatataca ataattttgc caaaaaaagc cttaaatgat 64140

atttgcactg aaaccctcag tgataataaa gccgaaaatg ttctatcact tgatatcaaa 64200

ggtatttctt cttttgctga caacatcatt attgcaactg caaattcgaa taggcatgca 64260

aagtctttat ccgaaaagtt agttgaggag ataaaagcta ataaaattag tatcatgggt 64320

gtagagggca agacagaatc aggttggata ttagtagact gtggtgaggt tgtagtaaat 64380

attatgaaga atgacataag agagttttat gatttagaag gtctttgggg tgaaaacacc 64440

ctcatcgatt cttcgaaata aatgctatta aatatcataa gtgttggaaa ctcaccttca 64500

tcttgggagt taacaggaat agaatattac acaaagcaaa tccctaaaga agtaagtcta 64560

aattttatta acgtaaaagg gcagcaacac ccaaaaagat ctacagaaga ggtcttaaaa 64620

cttgaatcta agttaatctc gtccaaaata gattctaatg gatatattgt ttgctgggac 64680

tcaagtggcg agtcgttgaa taattttgaa tttagtaaat tttttgaaaa atccatgctg 64740

gaaaatatga agctttactt tgtaattggt ggttcatttg gcatacctcg agatattctt 64800

gataaatcta ataagataat ctcgatctca agtctcaccc tacctcacag gcttttcaag 64860

attgttctta tagagcaaat ctataggtca ttttcaattc tcaaaaatct tccctaccac 64920

aaatgattga tctgaatgag aggtttgttg aaaaaagaag ctttttcaat agattgttgc 64980

ttatatattt tttctttggg gccctgtttt tattcttgct tttcaagacc tattctttac 65040

aggtttctag ctattctgac tatgaactag cagcactaaa gaataaaaca aaagaagtgc 65100

tagttcagcc tgttcgagga gtcatctatg acaggaatgg aaatattcta gttaataatg 65160

tccctacata tgacctaata atccaaccat caaaaattaa aaacttagat gatttcatta 65220

ttaatatttc taaaataata gagctatcag attcagaaat tgaaaacatt attaaaaatt 65280

ttaaaaggag tgcaacttat aatagagagc taacaattaa aaaagatctc tcgaaagaag 65340

aaatagcaaa atttgaagta agaagctacc aatttcagaa tgcatttata gatgttaggt 65400

atagtagaga aaataaatat ccttacttat tttcacacgc actcggttat gtaggtggtg 65460

taagtaatga taaggtttta tcaattttaa aaaatcaaga tttgaagcaa tctgaaacaa 65520

ctttaagta ttcaggtggt tttattgctg gaaaaacagg attggaaaat atttatgatt 65580

cagctttaag agggtccttt ggaaaaaagt tatttgaagt tgatgcaagg ggaaggcttt 65640

taaaagagct aagttttgaa aaacctatta atggaaaaag ccttttttact catttagatt 65700

taaattcaca aaaaaaagcc tttgaacaaa tgaataatag aaggggtgct gttgttgcct 65760

tagagcttaa atctggttct atagttacct acctaagcac tccaagcttt aatgtaaatg 65820

gtctttctaa tggcatgtcg tcggtagagt tcgaaaaact gattaatgat gtagacaagc 65880

catttttga tagggccggt caaggtcggt actctccagc ttctacaata aagccagcaa 65940

tagcattgtt tggtattaaa gaaaaaatag tagactggaa ctttacactt aaagatcctg 66000

gatttttgt attaccagag gatcagagga tttatagggg atggaagaaa ggaggtcatg 66060

gaacaattga tatgaagggt gcaatcatag aaagttctaa tacttttttc ttttctcttg 66120

cttataaggc tgatattaat aatttaatca gccatctttc tgagtttggt tttggcagga 66180

atgtttgtaa agattgtttt aatccagatt ctggattatt gcctacgcct gaatggaaaa 66240

tgaataatct taattttggc tggtttaaag gagataccgt taatttaggt gttggtcagg 66300

gctatatgag tgccactcca gttcaattag catattactc tgcatttctg gcaaaaaaag 66360

gaaatcttca agagctatca tttgtcgaga gtgacagcct aagcaatact gcttttataa 66420

ataatttaag catagataac tcagactggg atcaaattca ctcaagcatg attggagtta 66480

ttgaagatcc gagaggcact gctaaaagat taaaaccttt aaaatcatat gttgttgctg 66540

caaaatctgg aacggttgag cttgtcagca cacaaacaaa ggaagattac aaactagtaa 66600

ggcaaaatat tggtaacaga gaccatgcaa tcattgtggc ttttggtcca atgcctgatc 66660

cagagtatgc agtaagtgtt gttattgaaa atggtgaaag cggcggttct gttgcaggtc 66720

ctgttgctat tgctgtttta aatgagctta tcaataaatg aagaaaaaat tagactttaa 66780

aaactttagc atttattttg atcaatattt atttattgcg ataaccctgt tgtcggtcat 66840

gggtttattt tttttataca gcgcatcaca agaagatatc agcactgttg ctaagcaagc 66900

tgtattcgtt ggttttggtt tgctgttaat gtttgtagtt agccaacctg accctgattt 66960

ttataataca ttttctgggt tatttttttgg gggggggastt gtattgattt ttctaactat 67020

gatttttggt aaagaaataa atggagccaa aagatggctt gatttaggat tttttaccct 67080

gcaatcctct gagattatta aaatatcatt gccaattttt ttatcatcat atttatataa 67140

taagccactt ccaataagca ctaggcatac ttttattaca ttgatattaa taggttttat 67200

atttgcactt gtagctagac aacctgactt gggaaccagt ttagtagtat ttatgtcagg 67260

gggttatgta ttatttttag caggattaag ccgccgttta ttggatctgc aatagcctta 67320

tttttattat ccttacctbt tttatggaat aactttctag agccatttca acaacagaga 67380

gttttaactt atttgaaccc agacgcagac ccttatggta ctgcatggaa tataactcaa 67440

tcaaaaatag caattggatc aggcggaatt aatggaaaag gttatcagga gggctcccaa 67500

gcccatcttg atdttttacc agagacagaa acagatttta tttttgctgt tattgctgaa 67560

gagtttggtt ttattggagt ctgtattttg ttatcagtat ttdtctttat atkactcaga 67620

tgtttatatt tagcatttaa tgcaagagat agattttgca ggttaactat aggaggccta 67680

agtttagttt ttgcctctac attatttatt aatttagcaa tggttgttgg tgtagttcct 67740

gtagttggta tgcctcttcc atttatcagc aaaggcggct catctttgct atcctkttat 67800

atagcttttg ggattataat ttctatggca acacataaaa aattaatgca aagatgaaaa 67860

aaattatatt tataacttta atattcacta tttcaattac tgcggattat tcgaatcatg 67920

aagatagcca aatggtaata aatgaactcg tcacaaaaca cggttttgag gaatcttatg 67980

ttactgcaat cttaaaaaat gcaaaaaagc gtgatgagat gcttaaatct gttgctaatc 68040

ctgctgaaaa aacaaaaaca tgggatgaat atagggctat ctttataaaa acaaaaagag 68100

tttcagaagg caaaaaattt ataaaaaaaa atattaatgc tttagagagg gctgagaaag 68160

aatttggagt tcctaaagaa ataattactg ctattttagg cgtagaaact aattatggca 68220

gcaataaagg tggatacaga gttttagata gtcttactac tttaggtttt gatgacccgc 68280

gaagatctaa ttttttaga agagaactta tagagttctt ccttttaaca agagaaaata 68340

atttagatat caaaacaaca aaaggctcat atgcgggagc catgggatat gcacaattta 68400

tttcgtcaag ctaccgagcc tatgctgtag attttgatga agatggttac gttgatttat 68460

ttaattctgt tgatgatgca attgggagta ttgcaaatta tctttatgtt catggatgga 68520

agagagaagg aaagatcgta acaaaaactt atccaaacaa tgttagaaaa ttttataaac 68580

ctcatgagtc tctaacaagg ttcatacctt taatctttaa tgaagatgga aaagatcttt 68640

tttttattgg tgatgataac tttagggcta ttgctaagta taatattagc gatgtctatg 68700

caatggcggt ttattactta tcagaagagt taaaaaaatg aaaaaattat tattcacatt 68760

actatcaact tcaatattta ttcaagcaca gagttttgtt ccagattctc ctgagttaga 68820

tctgaagagc tatatcctaa ttgagccaaa caccaatact gttattgcag aatttaattc 68880

agatttggaa atagaaccag ctagcatgac taaaattatg actagctatg ttgtggctga 68940

tcagattgca aatggtttaa tatctcttga tgacgaagta ctaattagtg aaaaagcatg 69000

gagaatgcaa gggtctaaga cctttataga agctggaaaa aaagttacgg tatctgatct 69060

tttaaaaggt attatgattc agtcaggcaa tgatgcctct gttgcaattg cagaatatgc 69120

aggcggcact gaaagaggct tcgttgactt aatgaactct tatgctgcct ctttggagat 69180

gaataatacg atctttcaga attcaacagg gcttccagat gaaaatcatt tttcatcagc 69240

aaaagattta gccaatctga cagctaacta cattaataaa tttccagaag aatatgcttt 69300

atataagcag aagcaattta cttttaacaa tattaagcaa ttaaatagaa ataagctttt 69360

atggagagac gactcagcag atggtgttaa aactggtcat acagaagctg ctggatactg 69420

tttagttggc tcagcaaaaa ggggcggtat gaggcttatt acagttgttg caggaagtaa 69480

gtcagataat gatcgttttt tatcttccca aagattactt gagtatggat ttagattttt 69540

tacaacacag aagatgttaa gtgcagaaaa agaatatcag aatattacag tttggggtgg 69600

acaagaaaag atacttggcg tgggagttct agaggatata tctattactc ttcctagaac 69660

aagtttcaaa aatgttgaaa ctgtttataa agttaataac aatatccagg ctcctatcgt 69720

agttggtcaa aaagtcggga ctctagaaat aattagtaat gatgagattg ttctagttac 69780

ggatttggtt gctttaaaaa atattgaagc taaaggtttt tttggaagaa tatggtcaaa 69840

gttcgttctt tggatattta gcttatttgg tctaacagat gaaaacacca cttaaaggcg 69900

tttttaatgg ggcttttgat actgtagata acataaaaat atcacctttt tctcgagctt 69960

atacttttc tgatagcgta tatgaagtag ttcctttctt taattcaact gcaattgctt 70020

ttgatgatca tataaaaaga ttagaatttt ctgctagtca actagcgatg gccgtagatt 70080

taaaagaagt tatatttgaa attaattctt taataacatc atctgaattt agtaatggct 70140

atgtctatta tcaagttact cgaggcgttg atccattaag gtctcatatt catgagccaa 70200

atttaaaaat agaaaccttt ggctatgcaa aggcgcactt attccaatgg aaaccattaa 70260

gagtatcagt atgtgatgat attaggtggg ggaggtgtga tattaaatca acatcattgc 70320

ttggtaatgt tatgaacatg aatgcagcaa aactagataa ttgtgatgaa gttattatgc 70380

acaaagataa tttgttgacc gagggtggcg catctaatct ttttttttgta aaaaatgatt 70440

caatctgcac cccagctcta aatggaaata tacttcccgg cataaccaga gcattactaa 70500

ttaatgaatt aaaaaattat agtatagagg tcatcgaaga taacttcagg ctagaagatt 70560

tatcaaatgc ttcttgcgcg tggctcacaa gcgcaacgaa agggctggcc cccatttctg 70620

aaattagtaa cctagaatct cacttggatt tataccatcc tcttttcaaa aagagtgaag 70680

aaatttttaa taagaagttc cttagttaga agtcagttta ataactatat tatcaagctc 70740

gtaccaaaaa tctttatcac taagaccttt atttgcaaga tcaagctcaa atacattttt 70800

ttggagctgt attaagtttt gtagtttatg atttttaata aaatgcatat attcagaagt 70860

tttatttttc caaacccCag atttaattag actatctaca ggatttttac tttgtctagc 70920

attggctgca ctgttaataa ttttaccaac tatccaaact agaagaggtg cataatgatc 70980

ttccgctgat tttattgaat ggataatttt taaagcttgc ttggtattat ttgaaataat 71040

tttatcttca agctcaaatg gcataaattc tgcagactcc acagaaggtt ttctttcttg 71100

gccatcacca tctttataag tcagtcttag aagctttact tcattctgtt gggcaactaa 71160

gtttccagag ttcatttcag atatattttg cactaaagag ggcctatctt tttcagaaat 71220

aaaagatagt tgatgcttaa gccaaatctt ttcttcaaaa gatttaagtt ttccacaatc 71280

aatgatgagg gctatctcat ccatctgttt tacccactta gttgtgaaat taagcttttc 71340

attgcttgaa ttaataatta ttgcaatatt atccatatgg ttaatatttt caatttgaga 71400

tattttaatt atttggtcag gtatttttcc ttgatcatga ttaatctcaa ctattatttt 71460

tgagccaaat aaagatccag aagcattttc aataatagtc tgatctattt tatcaaaccc 71520

atctttatta ataattgttt tttctttgaa ccctttattt gataaatgtt tgagcaaaag 71580

atctttagag ttatttttta agacaacctc agatccaaaa ataaagaaga tattttgtga 71640

ctgatctaaa tatttttgag ttgtcattgc ctcacatttc aaaagcatgc acctcaaaaa 71700

ttatttgatc aattaattcc ttctgcattt cagactcaag agatttaatc atttgatctt 71760

gtgcaaatgg attaagttca ttcgatttat atctcttgta gctaacaagc tttttactta 71820

tttgtttatt tccaatcatt tttatatgta tttctaaatt aatttctcct tcaagagctc 71880

ttagagaaga gcctccatag atatcatatt tatttaaaat atagtcttgt attagaatct 71940

gattttgacg attctcagct tctttttctg tattgaagag gattgctaac ttttgctcaa 72000

aagaattagg gacactacta tcaaaccgaa aattaaatag atctttttta tctagatcta 72060

tatttagttg attaaattgg cagccagtta aagatatcaa caagcaagtg tataaaaaga 72120

aaggtcttag tttcataacc tcatagtatc tatctgaaga atatatatca aagattaatt 72180

ttaaataaca aaatttatta ttttttcttt aatataaata gttttttttaa tagccgagtt 72240

gtttattgtt gatgccacat tgtcgatagc cagtgctaaa gcttctatat ctttttgctc 72300

aaggtttttg tctatcatta ccttacctct caccttttcca tttacttgaa ctattaaatt 72360

aaattcagaa acttctaata actcctctct aagaacaggc caagaagatt caatttcttc 72420

ttgtgcaaag tcaaagtaaa aattattcca taaatgttgt gagatatgag gcgcaatagg 72480

attgagagtt ttaagaataa ttattattgc ttcattaaga caatattgat ttgagatcga 72540

cgcattacct tctttaaaag aatcaggtat aaagttaact agctccatta tcgaagcaat 72600

ggctgtatta aatgaatatc ttgtttcaaa gtcatttgta acctttttaa gagtattatg 72660

cgattttctt cggagctcta cttcttgttt cgaaggatcc ttgggctcct ctaagtcaat 72720

aaattttcta ttgctgacta agttccatat ttttttcata aatcttgagg caccttctac 72780

agatgactct gaccattcta gactttgctc agggggagct gtaaacatca tgtaaagcct 72840

tacagtgtca gcgccatact tttctatata agattgagga tctacagtat ttccttttga 72900

tttggacatt ttagccccat ctttaagaac catgccttgt gtaagaagct ttttaaaagg 72960

ctcattgcct tcaactaaat ccatatctct aagcgcctta tgaaaaaatc ttgaatatag 73020

taagtgcagt atcgcatgct caatacctcc tatatataaa tcaacaggca gccaatattt 73080

tgaattttta tcaaacattt catctgcatt gtcagatgaa gtaaatcttg cgtaatacca 73140

tgatgagtcc ataaatgtat caaaagtatc tgtctctctt tttagtcgat cagaaatatt 73200

ataaaaatct tcattttgac ttaagggaat aggtgccgag ttctttttta gctctggaag 73260

cactataggc atatcctttt catcaataac tcttggttca ccattttcat aaacaaccgg 73320

aatagggcaa ccccaatatc tttgtctgct cacaccccag tctcttaatc tgaactggat 73380

taactgctca ccaaggtttg cgtctgctaa atctttaata atttcaagag atgcctcatc 73440

agagtccatg ccatcatatt tatcagagtt tattaatttg ccttttttgta caactggaag 73500

ttcattatta ttatcaaaac taataacttg aggaatctct agattatatt tagatgcaaa 73560

ttcgaaatct ctttgatcat gagcaggaac acccatcact actccagttc cataatcaag 73620

aagtacaaaa tttccaatcc atacgggtat cttcttcttt gtaattggat gaattacatg 73680

cattccacta ttaattccaa gtttttcagc tttagccata tcagcttcag cagctttcac 73740

ttctttgcat ttgtttagaa agtcttttat cgattcatta ttttttgaca accctattga 73800

tatagagtga tttggtgata ttgctaaaaa agaaacacca aaaattgtat caggtcgtgt 73860

tgaaaatacc tttaaagaat catcggaatc ctcaatcatg tatttaattt ctgctccctg 73920

agatttccca atccaattcc tttgcattgt tttaacattt tcaggccaat ccacctcatc 73980

caaagatgtt aaaagttcct cagcgtagtc tgtaattttt ataaaccatt gatcaatttc 74040

ttttatttca acttgcgccc cagacctcca tccttttcca tctataactt gctcatttgc 74100

taaaactgtc tcatcaactg gatcccagtt cactaatgat tttttcctat aaaccaaacc 74160

tttatcataa aacttttaa atattaactg ctcccactta tagtattccg gttcacatgt 74220

tctaagctct tttgaccaat catacccaag gcccaaagat ataagttgct gtttcatatg 74280

ttcaatattt tgattcgtcc aatcttttgg gctaacttta ttagcaatcg ctgcgttttc 74340

agcaggaagc ccaaatgcat cccagcccat aggctgaaaa acattaaagt tattcattct 74400

tttatatcta gatatgacat caccgatcgt atagtttctt acatggccca tatgtaattt 74460

acctgatgga tatggaaaca ttgataggca ataaaatttt tctctaccat caggattagc 74520

tttaaatttg tcttctttta accattcatc ttgaatggtt ttctctattt gacttgggtt 74580

atattcagga ttcatttttt taggaactca ttttctaagt aattaatagt atgtttattt 74640

tctttaaagg tatcatcatg cagaatcctt tgatgaagag ggtgatttgt tttaatgccc 74700

tctataaaaa attcatctaa agcactcagc attctcttaa tagccgagct tctagaattt 74760

gcctgagtaa tgatttttgc tagaagtgaa tcatagttag ggggaactct atatcctcca 74820

taaatatgtg agtcatatct tatgccaaaa ccgccaggtg tatgcatttt tgtaattgtt 74880

cctggggatg gttgaaaatt atcaggatct tctgcattaa ttctgcattc tagtgagtgg 74940

ccatgaaaat taatatcatc ttgatttagc tcaattggca tttcaagagc aattcttagt 75000

tgtgctttta ctaaatcaaa gccagttatc atttctgtta ccggatgttc aacctgaatt 75060

cttgtattca tttctataaa atagaattga ttatcttcgt ataaaaattc aatagtgcca 75120

acccccttcgt aatttatttc ttcacataaa ttgacacaag ctattagtgt tttattaaga 75180

gcttcttgat ttatattaag tgctggagct tcctcaatta ttttttgatg tctcctctgc 75240

atactgcaat cccttgtacc taaatgtatc gcctttcctt taccatcacc aactatttga 75300

acttcaatat gtctagggtt cccaataaat ttttctagat aaatggtttc attgccgaat 75360

ccatttttag cttcctgcat tgttatttct gcatgtccaa taagatcttc ctctctttca 75420

acaactctca ttcctcttcc accgccacca gccgttgcct taatcataat tggatagccg 75480

atatctctag caatttttt aaactcatca ttatcagatg gaatctcatc tttataacct 75540

ggaacgattt gaattccaga tttttcagcc agtgtttttg ctgttatttt gtcgcccatt 75600

ttttggattg tttctgaggt tggcccaata aatttaaatc cacttttttc acacatttct 75660

gcaaaattat gatcttctgc aaggaaccca tatccaggat atatagcatt agcacttgta 75720

agttctgcag ctgagagaat ggcaggtata tttaggtagc tttgagttgg agatgcaggc 75780

ccaatacaaa cagtttcatc agagaatctt aaatgtttta gatctttatc agcttctgag 75840

taaacagata ctgtcttgat accaagctct ttacaagctc ttatagctcg aagagcaatc 75900

tcaccacgat tggcaataag aactttataa ctcattttaa ttgacagtta taatttttg 75960

tccaaattca accggacttc catcttccac gtcaatactt gaaatcttgc catcaaattc 76020

tgatttaatt tcattcatca ttttcatggc ttcaactata cagagcacat cacctacttt 76080

tatattgtct cctactttta caaatggatc tttttcggga cttgggcttc tataaaaagt 76140

tcctactatt ggagaggtaa caacatcccc tatgacagtt tgcttagcct catccaattg 76200

atgagttgtt ggtgagatag ctggctcatt tttgacaatg attggttttg aaacaaattc 76260

ttgattagag ccgttatctc ttgaaattct tactgactca tctccttgac ttacttctat 76320

ttcttttaaa tcagactctt gaagcatttc tataagtttt tttattttcc taatatccat 76380

ttatttaccc ctgtatttta atatgccctt aagcatcgcc tcttcataac ccttagcacc 76440

aataccagtt atcacttctt cagctatatc agatagatat gagacatgtc taaattcctc 76500

tcttgtatat atgtctgaaa ggtgaacctc atagaatggt atgttgacac caagaaatgc 76560

atcccttata gctatgctcg tatgagtata tgcagcagga tttattatta caaagtctat 76620

tttttcttca atagtgctat gtattgattc tattatttca tgctccgcat tactttgaaa 76680

agatattaaa ttgcattgat tttgatttgc taagactaat aaatcttgtt gaatatcttc 76740

aagtgatttg ctgccatata cttccttttc tctagttccg agaagattga ggttggggcc 76800

atttataagc aatatattca tataatagat tttaacagaa atttacagat tttttaggat 76860

tttaaagata tttttataag agttgatttt tttgcatggg atagcaaaaa cccgcttcag 76920

agcatccctg atagtatatt aaaacctccg ataagttcaa tgaagaattt atttcaatgc 76980

ttataataaa ttcatctcta agaatctcag tctcgccaaa aaattcatcc ctatatagat 77040

ctttacttga ctcaagcgtc ttaaatggga gcactttatc tttaaatttg agctctatac 77100

tatccaagta catataataa ccatctctta tttgccaagt tatatatgct gcttgttttt 77160

caacattggt tgttaaagca aatacttcat tggcttctgg gaccctattt gagttttcaa 77220

aaagatttgc tgaattcaat tcacctgcaa tcacattgga tagtagtata attattaaac 77280

ttttgatcat gaagacttaa gaataaaccc ctaagtactt aaaataaaga ttttattaaa 77340

taacacggta gttaaaaatt tatgttccag actttcgcac taaaaatttt cttttatatg 77400

cctatttggc ttttaaaaat aatttttttat agaaaaagaa cagtaataag agggcatcaa 77460

tttgatgctc aatctgctgc attattgtct ttgcttccaa agaaagattt atctgaatta 77520

ttagatggtg aaattgcaaa agctagaatt actcttgaag aagcaagaat tcaaaataaa 77580

gtttctttaa caccgtctat acaagtcaga aaagtagatc atattttacc aaagcatgat 77640

ttaattctca gagaatacaa gccgcatcaa gaggatttaa aaaaagttat tctctatttt 77700

catggaggag gttatgtcct taactcagtc aatacacatg atgatatggt ttcatatatg 77760

tcagataaaa taggagtaaa gttttattct ctagactata gactatcgcc tgagagcaaa 77820

tatcctgatt ctcttgatga tgctctagat gctttttctt ggctcatcgg ccagggatat 77880

ggaccaggtg atatttcagt ttgtggagac agcgcaggcg ctcatctagc tgcttctttg 77940

tgccattacc tagctgaaca aaataaagat ttgcctagta gccagctact aatatatcca 78000

atgtgtgatc cgtcctgttc atctgagtct tataatttat tatcttcagg atatcttcta 78060

actaaaaaaa ctatgatttg gttttgggat aagcttagaa cttccgaagt aaacaataac 78120

gattcggcct ttaatctctt aaaatttaat tttgaaaaaa ctttaccgcc aacaattatc 78180

gttacaggtg gctttgatcc tctatgcgat gatggagaaa aatatgcata tttattacat 78240

aaaggtaaac ataatgtgaa acaattacat tatccaacaa tgtttcatgg gtttgcatca 78300

atgactaaat tgaaagcagc gcagatagcc gttgaagatt ttttaaaaga atataagaaa 78360

atactatgag taaaatttta gaagtaagtg acttaagcat caatttttca acaagggatg 78420

gattgtttaa tgcagtggat aatataagtt ttgatataga aaaaaatcaa accttggcct 78480

tggttggtga gtcaggttct ggtaagtcgg taactgctat gtcaattctt cagctccttc 78540

aaaaaccaca agcatcatat tccaaagagt cttctattaa gtttaatggc gatgagataa 78600

taaatgccaa gtatgaaaag ttactttcct tgagaggaaa tattatatct atgatatttc 78660

aagagccgat gacctcacta aacccttatc acagagtagg taatcagata actgaatcaa 78720

tactacttca ctcaaaaagc tcaaaaaaag atgcaataga tgaagcaaaa aaattaatgg 78780

cacttgttga gattgatgat gttgaaagac ggttctatgc ataccctcat gagctttctg 78840

gagggcagcg acaaagagtt atgattgcta tggcccttgt taataaacct gagctattga 78900

ttgctgacga gccaacaacc gctcttgatg taactatcca agcccagata ttagatctca 78960

tgtctaagct taaaaatgaa ctaggcatgt caatactttt tattactcat gatctaggcc 79020

tcgttcaaga attttctgac aatgtttgtg ttatgaagaa tggcaagata gttgaacaag 79080

gaaatactgt tgaggtattt aacaacccct ctcacgaata tacaaaaaaa cttttagatg 79140

cagaacctca gcccaaatta gataaccctg taagtgatga gccaataatt gagatcaatg 79200

acttaaatgt ttactactca ataccttcaa ctaatttttt taaaaagaat acttttcatg 79260

ctgttaaaaa tacttccttt agtatttata aaaatactac aattggcctg gttggggaat 79320

ctggatctgg aaagtcaact ttgggtaagg ctatagcaaa cttagtttct tataagggga 79380

atattaaatt tgagggaaga gatatcaact caaattccca aaaagaaaat aaagaattga 79440

aaaaaaatgt ccaaattgtt tttcaagatc cttatgggtc attatcacca cgaatgacag 79500

tgggggagat agttggtgaa ggtttaggtg ttcactttaa gcttacaaaa aaagaaagag 79560

acgaaaggat agataaggtt ctgtcagatg tcggtatcga aatagtagct aagaataaat 79620

atccgcatga gttttctgga ggccaaaggc agagaattgc aattgctaga tctttaataa 79680

tgaatcctgc ttttatgatt cttgatgagc caacatcagc attagatagg tctattcaaa 79740

ttcaggtaat cgatttattg aaagagatac aaaatgaata tgggcttact tatcttttta 79800

taagtcatga tttaaaggtt attagatcga tgtcagactt tatttttgtt atgaaaaatg 79860

gagaaatcgt agagtcagga ccttctcaca aggtctttga aagcccagag caagactata 79920

ctaaaaaatt actatcagct gctttaaagt atgcatctga ataattaaat atatymcmtm 79980

tggcaaatag aaartattca aaagagctcg ttgacggtcc taatcaagct gcttctagat 80040

caatgcttag aggagtaggt ttcacatctg aggmtttcac aaaaccattt gttgggattg 80100

cttccacagg agcaaaagta accccatgca atatgcacat aaatgcactt tcagagatcg 80160

ttgagaaatc agttgatagt tcaggaggaa agggtgttct ttttaatact attactgttt 80220

ccgatggaat ttctatgggt acacagggta tgaaatattc tcttgtttct cgagaggtaa 80280

ttgcagattc aatagaaact gttgtgggat gtcttggtta tgatggagtt attgctgtcg 80340

gtggttgtga taaaaatatg cctggatgca ttattggaat ggcaagatta aatagaccat 80400

caatatttat atatggtggt tctatcaaac ctagtaaaga aaataccgac tatgttactg 80460

tttgtgagaa aactggagag tactcaaaag gcgatcttaa agaatctgaa ttaattcatg 80520

tagaaaaaat ttccgtaaaa gggcctggat cttgtggggg aatgtatacg gcaaatacta 80580

tggcttctgc gattgaagct ctaggcatga gtcttcctgg aagcagcagt caagatgcaa 80640

tttcacacga caaagaagat gattgtttta aggctggcga agcgataatg aatttattag 80700

aaaaagatat taagccttca gatattatga ctaagaatgc ttttgagaat gctataacaa 80760

tggtaattgc tctaggaggt tcaactaatg cagttctgca tttattggcc atggcgcatt 80820

caataggggt tgatttagag ctagatgact ttacaagaat aggaaaaaaa acacccgtta 80880

tggcagatct taagcccttt ggttctcatt atatgtctga actcaatgct aatggcggta 80940

ttcagccact aatgaaaact ttgcttgaga agggattact acacggcaat tgtcttaccg 81000

ttaccggtca gacgcttgct gaaaatcttt ctggaataaa accttacgag cctgatcaag 81060

agataattaa atcatttgat aatccaatta aatcaaatag ccatcttaga attctgtatg 81120

gcaacttagc gaaagatggt gcagttgcaa aaattacggg taaagaagga acttcctttg 81180

aaggaagtgc tcgtgtattt gattcagaag aagaaggggt taaagcaatc ctatctaaat 81240

ctataaaagc tggagatgtt gttgtaatta gatatgaagg gccaaaagga ggtccaggca 81300

tgagagaaat gctaaaacca acatctgcca taatgggtca aggtcttggc gatcaggtag 81360

cttttataac agacggtcgt ttttcaggag gcactcatgg atttgttgtt gggcacatta 81420

ctccagaggc tgcagatggc ggcttaattg caataattaa agatggcgac tctatattaa 81480

ttgatgcaga ttctgataag ttaattctta atatttctga ggatgaaatt tcaaatagac 81540

taagtagatg ggtaaaccca aaaacgcctc ccaaaaaagg agtcttagca aaatttgcaa 81600

aaagtgttaa atcagctagt cttggagcgg taacagatta aatatgtatt ttaaaagaaa 81660

atttccaaat agtagactaa gaagaatgcg tctcaattca aacctcagag acttgcttgc 81720

tgaagttagg ttgtctacaa atgatctaat tcagccatta tttataaaag aaggcttgag 81780

tggaaaagag gctattgaaa gcatgcccaa tattaataga tatggacaag attcaatttt 81840

ttcagaaata gaagagctac tagagcatga tataaatacg attgccctat ttccagttat 81900

taatgattcc aagaaaaaca gcactggaga tgaggctatc aatgcatcta atttgatgtg 81960

tgaaactatc agtaacataa agaaacgatt ccctgaaata atcttaatat ctgatgttgc 82020

tctagaccca tataccgatc atgggcatga cggtatttta aaaaatgatt atgttgataa 82080

tgatgagact ttagctgttt taaggaagca atcactaaca ttagctcagg ctgggacaga 82140

cataattgca ccatcagata tgatggatgg aagaataggc tctataagag aggcattgga 82200

cgaaatggat tataaaaata caatcctact atcatatgca gcaaaatata attcaaagtt 82260

ttatggtcca tttagagatg ctgttaattc agcttcaagt ctaggcaagt cttcaaaatc 82320

cagttatcaa atgtcaccaa aaaatataaa tgaagctcta catgaagttg ctatggatat 82380

taatgaaggt gcagacatag tcatggttaa gccaggtatg ccttatctag atataatttc 82440

aaaagtaaaa gaaaccttca aagtacctac ctttgcatac caggttagtg gtgaatatag 82500

catgcttaaa ctggcgattg ataaaggatg gcttgaaagc gatgttatgt tagaatcatt 82560

aataagtttt aaaagagcgg gagctgatgc aattctaacg tacgcagcta aagaaatttc 82620

caaggagata actaacaaat gagcaatgtg atagaaattc gtgatgaaga aagctttaat 82680

agcgacgtct taaattcaga aaaacctgta ttggttgatt tttgggctga gtggtgtgga 82740

ccttgtaaac agcttgcacc aactgttgaa acagttgcag cagaaaaatc agaaacatta 82800

aaggtttgca aaatggatgt tgattcaaat agagagattg ctgctaaata tggaataagg 82860

tcaatccctt cattaattat atttaaaaac ggagagcctg caggagttga agtaggtgct 82920

ctaaccaaac aacaattaga ggactttata agtacagtag tttaactttg caaagacttc 82980

tttgcatatt gcaagaaata ggattatcat ttcgacttct aaggctgaaa gccactcaaa 83040

acaaaaaccc acctttttcaa tcataaaaac aacaactaga acggaaataa ctaaatgaac 83100

cttactgaaa ttaaaataaa accaataaat gaacttgtag atatagctac tgagcttggg 83160

cttgaggatg ttggaaggct gaaaaagcaa gagataatat ttagaatatt taagcataag 83220

gcttctgaag gtgttgatat ctatggtggc ggagttcttg agattttaaa tgatggtttt 83280

gggtttttgc gatccccaga aggctcttat tgcgctggcg aagatgatat ctatgtttca 83340

ccaagccaaa taagaaagtt tagcctcagg aagggagact cagttgctgg gaagataagg 83400

acccctaaag ataaagagcg ctattttgca ttaatccaag ttgatactat taatggtgaa 83460

gagccaagaa agactaaaaa caagattctt tttgaaaatt taactcctct ttttcccaat 83520

gaaagactaa tccttgaaca aggaacaggg tctaatgaag atctttcatc tcgaataatt 83580

gatttgattg ctccaatagg aaaaggtcag cgtggactta tcgtttctcc acccaaggct 83640

ggtaaaacct taatgcttca aagcatagct cattctatta aaagcaataa tccagaagta 83700

gagcttatag ttcttttgat tgatgaaaga cctgaagagg taacagagat gtcaagaact 83760

gtaaaaggag aggttgtagc tagtactttt gacgagccac ctactcgaca cgttcaagta 83820

gcaaatatgg ttattgaaaa agcaaaaaga cttgtagaac ataagaaaga tgtagttatc 83880

ttattagatt ctattactcg tcttggaaga gcatataact cagttcagcc tgcatcagga 83940

aagatattga gtggtggagt tgactccaat gctcttgaaa ggccaaaaag gttttttggt 84000

gctgctagaa atcttgaaga gggtggaagt ctcactattc ttgctactgc tctagttgaa 84060

acaggctcaa agatggatga agttatttat gaggaattca aaggtacggg taatatggag 84120

attcaccttg aaagaaaaat agccgaaaaa agaatatatc ctgctattaa tattagaaga 84180

tcgggaacaa gaagagaaga tttacttact gctgaagatg aattacaaag aatgtgggtc 84240

ttaaggaaaa ttttagacga tatggaagat gctcagtcaa ttcagttcct aatagataga 84300

ttgaaatctc ataaaacaaa cgatgagttc tttacttcaa tgaaaggggg taatggcaag 84360

aagactagat aaagtttttt gccatatcaa tcatcatctt atcagttggg ctttgcgata 84420

cgtgaatttc taattcttta aactcatttt gacatctatc ctttatattt tctgaagcaa 84480

caataaatat ttttttctt aaaactgcat cgtccagatt tgttattaag aatttaagag 84540

tactaaaatt atagattaaa aaaatttcat tattatctgt aacttttggt atttgctcca 84600

gcaaatagat tacttcatag caaactatct catctagact agccttaagt ttttgttgaa 84660

gaaaaccatt tgaattttcg ccgcaaaata aaagactctt tcctagaaaa ttttttctcta 84720

ttaacttaag aattccttca gatgaatggc tttgtggaaa atgagatttt atgccacttt 84780

caagaagttt attggaagtt gcgggcccaa cagacaaaaa attgtgtgga agatcatcta 84840

aatcgaaaaa agattttaaa atatcaagtc cgtacgaagc agcagcttgg ctagtaaaaa 84900

ttaagtttga atatgaatga atatttttaa ttttatcgat agcgattttt gaagggtcga 84960

ttgaattaat tttagaaaga taaatatttt taagagctat ttcttgagct tcacataaag 85020

atattaggtt tcctgataaa tttttgggcc tcgtattaat tatcattttt taaaattaaa 85080

gatttcgctc cttccaaaat aaactcatca gcaaataaca taatatctat tgcaatatct 85140

tgaaaggaag atatcttttc tttataaatt ttttcgttgc cttcataaga taatattttc 85200

cctgatattt ttatttggcc atttttatct tcacataaaa tagctattgg agacaggcaa 85260

gtaccttcca tggcagcaac aaaagatcgc tctgcactgg caagaattaa ttctttaggg 85320

tcaccaatat tttctaaaag ctcaataata tctttttttat ctgacagaca ttcaattgct 85380

atatatccct gagatgcaga aggtaacatt tcttcaattg agaattcata tgaattttgt 85440

tttaaaccaa gccttttttat agcagcctta gcaactacca gcccatcaaa cagaccatca 85500

ttgagtttct ttattctagt agctatgttg cctcttactg gaatagtttt tatatcaggt 85560

cttaagttat taatttgtgc ttttcttctt ggaccagaag taccaatagt tgaatttcta 85620

gcaaattcag aaaatgattt cccatcctta gatagaagca ggtcttctgg agattcccta 85680

ctaaaaacac ttattatttt aaactttgga tcaagctttg ctggaacatc ttttaaacta 85740

tgcactgcaa tatctgcttc atcagcctct agagaggact caagtgtaga aatgaatagg 85800

ccctttccac caatttcatg aagaggttta tctgtttggt ctccttctga tgtcatagga 85860

acaagctcaa ccttaatatt attgatctta gctaataact catctgcaac aaattttgcc 85920

tgatacattg ctagttctga ttgccttgta gctattctta ttttcatttt gtttccaata 85980

aaagagcctt cacatcgcca acactctttt ctttcaagat agtgaattcc tcaggaattt 86040

ccaaggtagt aaatttacta tactcaaggt agattttaca agatggcttt atttcattct 86100

ttcgaattat agattttaga acttttaatt catattcttc gccaaaagga ggatcaagaa 86160

gaattaaatc aaaacgagat aagtcatttt ttttaatcca actaaatgca tccttaaaaa 86220

aaactttaga tttatccttg atgccaagaa gttgaatatt ttttgctaac acagaatagt 86280

ttttttttatt aagttcaacg aacacaactt tttttgactg tctggatatt gcttcaatac 86340

caagcgcacc cgttccggca aacaaatcaa gacatattaa attttcaatc tcaaattgaa 86400

gccaattaaa aattatttct tttaatttat ttgaagttgg tcttaaggaa tccttaaatt 86460

cgaaaggtat ttttttacct tttaaataac ctccagtgat tctgatattg tttttcattt 86520

ttttgcaaa atgggtatgc ctatttatta ataaatata attamaaata catttaaact 86580

aagttataat tcatccatgm gtcctacaag ataattttag aaaagcaatg aggagctata 86640

tttactctgt cagtgtgatg tcaaatgttg acgagaataa aaagtttagt gctataacag 86700

tttcttcagt tacctctgtt tctttagatc ctcctagttt gctcgtttgt atcaataaat 86760

cagctggaat tcacaactca ataaaagaag ggtcctcttt ttgcataaac cttttaaata 86820

aaaatcaaga agatatttct aatctatgca gttcatttaa gaccgaaggt gatagattta 86880

atagtggtga ctgggattta agcggcactc cgtttttaaa aagtgcccag gctaatattt 86940

tttgtactgt tgatcaatta atttcatacc acacacatac tattgtgatt ggtcatgtca 87000

caaactctct tagcgatgag aaaattaata cactgacata tgttgatggt agctatgaat 87060

aaattttcaa aaaatgtatt ttttatttta ataatactca actcttttt tcttgcctct 87120

aacatttttg ctagccagga agagtgtgaa gaaaagccaa gtgtttttat tatctctcct 87180

caagacggtt ttatctcaga atctaataat gtaaaagtct tatttggatc aaaaaatatt 87240

gaaataaatc cagctggcaa aggtgagatt gcaaaaaata aatgttttgc aagcgggcat 87300

caccatcttt tagttaatat cgaagcattg ccagagagct ttattccttt tgacaagggt 87360

tatttacatt ttggaggagg tcaaactgaa acaattcttg atcttgatcc tggaacctat 87420

tctctccaac taattcttgg atcttatgtg cataattcaa aaatgcaggt aaataacttt 87480

aaaggtcaag gacccttttt atcagaaaaa ataacaatta cagttaatta gagattagac 87540

cagttataac tttatctaga tgttcatcta agttattagc aattatattt gcactagaaa 87600

taggaccaga attatcgtca taatcatcac caactacatt caccttttctt attatcccaa 87660

caagaccatg caacatagac caaagagtta tacatttaaa ggcaatcact tcctcaggct 87720

cgtctgctag attagcaaaa ctttttctca tattatcgta tgttccattt gcagatttaa 87780

gaagatctgg gtaatcggca aagttaccaa cagctgttcc aaacatcaaa tcatatgtat 87840

gtgcattttt taaaccaaac cctatatatt tgcttgcatt agtaacaagt tttttctttg 87900

taatttttttt tggattctca aaaaaaacaa gctcattaag ttttttaaag ccaacggttg 87960

caacagcggc atatacacat tcttttgttt caaaatgcct ataaggagca gtttgagaaa 88020

caccactttc ctttgcaagg gatctaatac ttagtttagt gtaaccatct ctatcacaaa 88080

gcctgcatgc gcattctata agttcttcct ttaagtttcc gtgatgatag ttattcataa 88140

tttaatttta atgttgacac tgctaacata tatcatgtta ttatgtatac accgcataca 88200

ttaagttgat tacatattaa agtcaaatac agatatatga acataacaaa aataaataac 88260

accgtcatag ctcttttatt aggcaatgcg tttctatcaa atcttgaggc tttagaagtt 88320

cttgaggtta aaatgcttga tgaatatgct gtaactagag aatttcctgg aaagctcatt 88380

ccatcagacc agtctaagct agcatttgaa atacctggaa agataaactc tattaatgtt 88440

gatatcggag atgaggtcat cttaggggat gaacttgcct cattggatga tagagaagct 88500

ttagcacaat taaatcaatc aaaggctaaa tttgatttag ctgaacaagt actagcaaga 88560

tatataaatc tcagagcaga tgggcatatt tctattcaag atcttgataa ggctgaatct 88620

gatcaaatag tagctaagtc gcagtatgat ttttatagag ttaaatttga gcaaactaag 88680

ttactagctc cttttaatgg agttattcaa aatagatttc tagatacagg atcagtaatc 88740

aatgcaggtg tccaagtttt agaaatttta ggctctagca atgttgaagc aagaatttct 88800

attccaatga actatatgaa caaggttaag attggagatg agtatgaatt tgatatcaga 88860

ggaatatcta caaaagctac gttagagaga ctggctccca tgtcaaccgg aggctccaat 88920

aataggttag caatttttag atttgatacc ttttttaatc caggatcaat agtaaagctc 88980

aaactaagca tcactgagaa agcaaaaggt acatgggttc caattaagtc actgtcccag 89040

tccgaacaag gtatttgggc catatatacc attaacgagc aacaagtagt tgttagagat 89100

cttgttgatg ttatttattt tgaagacgaa tatgcttttg tcagcggaac acttaataat 89160

ggtgatttag taattttagg cggagctcaa aaaattattg aaggaaaaat aataaaataa 89220

aatgaatgtt attaattttc taatagaaaa gcctaggata ttatttctaa ctttagcatt 89280

tatattactt tctggaattt cttctgggct ttcagttcca attcaagaaa accctgaact 89340

ggctgagaga tggggaggtg ttcgtatttt tcttcccggg gcatccccag aaagaattga 89400

aacagagata gtaaatgatc tagaaatcaa acttagagaa gttgaagaaa tcgatgagct 89460

tgaatcaatt attactcaag gtttttcaac aattgtagtt gaattaaatc aaagtgtacc 89520

tcctatactt attgaagaga cttggtccaa ggttcaagac aagctcaatc aaatagttat 89580

tcctcaaggt gcagaaatat ttcttgatag aagcagtggt ccgcctatca ctgttcagta 89640

tgctgtaacc tggaacggca gtggagatgc tccactaata atgatgtcca gactagcaag 89700

ccagctaaaa agaaaattaa gctcaatagg ctcatctcat caaactgcaa tttttggtga 89760

aacagatgaa gaaatttaa ttgaactaga ttcatcaaag ctatcttcgc ttggattatc 89820

atttcaagat atcgcaagtg ctattcaagc cctagatgca aaaaaaccta ttggtgtatc 89880

ctcaaacaac aattctgagc ttttatatag actcaaagat aatatacaga gcattcaaaa 89940

actctcagaa atacctatca aggttattaa taaatcagag atcatacagc tagatgatgt 90000

ggcatttatt tcaaaaatcc cggtttctcc tattgaagac atattcttgt ttaatggaaa 90060

tgtagttatt tctgttgctg gaaccggatc attttctcaa agagtccatg attatgtaga 90120

acgcgcaaca attgttgtag atgagatgag agaaactctg ccgactgaga tcactataga 90180

tttagtttat gacgaatctg cttacacaac taaaaaattt aatgagcttg taaaaagttt 90240

ttcattagca atatttttg ttttagcttt aagtcttttt tttcttggaa ttagatcagc 90300

aataattgtt actcttatcc tgccattttc tatttgcctg gttatgattg gttgtaggtt 90360

tataggctta cccttgcata tgacatctat cactggaatt attattgcac taggattgct 90420

tatagataat gggattattg ttgttgaaga ttataagaat agaagagcat ctggattaaa 90480

tatcaatgat tcaatttcac aaggactaaa aaacttatgg gctccattag ctgctgcaac 90540

agcaacaacc gtcttctctt ttcttcctat tgttactgga gaagggtcga gtattgaatt 90600

cgtaggcggc atggcaatga cagtcattat gtctataaca tcttcattag ttttggcgtt 90660

attaatggtt ccagttctga tgagttatat ggaaaaaatt ccgttcttta aggatgtgga 90720

tattagcaag gaagggtata gaaatgaaaa aatccttaat aaatataggg ccttttaaa 90780

ctgggcgttc ttagttccta gaagagcaat catgatatcg cttgcattgc ctgttctagg 90840

attctttctt tttaattctt tacctaaaga tttctttcct gctcaagata gagatatgtt 90900

tagagttaat atagaactgc cttctaacgc ctcatcactt actacaatgc agagagttaa 90960

ggaaattaga gaagatattc tagatagtga tttaatttca atagaaaaag attattcgtt 91020

tatcggcaga atgatgccta gagttttgat gaatgttgtt ggtggagaag aaaaacaagg 91080

atccaataat attgcgcagt ctgtattttt tgctactgat tattatgaaa tgattgaaaa 91140

ccttccagat ttatcaagaa gactggttaa aaataaccct gacattatag ttaatattga 91200

tagtttctcg tctggccccc cggtttttc agatgttagt tatgtaattt ttggagatga 91260

tccagattta ctaaaatcac ttggtgagga gctagagcta attattaaca attctcctga 91320

tgtgagtctt acgaaatctg caacttcaaa ctcaataacc aatgttgagt ttgaacttaa 91380

cagctcaaat atttcactgt ctggtcaaaa tgccaattat cttgtaaatg aaatgtttac 91440

tgcaaacaat ggaatatttg ttggcactat gttggattca aacaaagaaa taccagtcag 91500

gctgaaaggg ctgtctaata aaaacaatat tacgggaaat actagtttta taacaatgcc 91560

ctctcaaggt ggttttgagt attttgatag tttcggaaaa agctcactaa caaacaaatc 91620

gtcaacaatt actaggcttg atggccaaag aacaaatgat gttgagggct ggatttggac 91680

aggtacgctc ccgtctgcta ctgaaaaatc tattaaaaaa gatgttaaag attttgaatt 91740

aagattgcca ataggctatt cattaaaaca acttggcgag gctgaaagca ggggccaatc 91800

tcaagcctca ttatactctt cagcttttat gtatttcatt cttataatag taggcttggt 91860

tatggcgctt aattctttca gagaggctgg tctaattttg tctgttgcat tcttatcaat 91920

tggactatcc tttcttggtt tatttatagg ccagcaaaat tatggattta ttggaactat 91980

aagtgcaata gggttaattg gcttatcaat aaatgattca attattgtct tatctcacat 92040

aaaagaagag gctgagaaga aatcactaac caaagctgag cttgttgaag ttgttatcag 92100

gtctacacgt catataatca ctacctcttt gacaacactt ggtggttttc ttccacttat 92160

ttttgcaagt gtattcttca aaccgcttgc ttgggcaatg agcattggag tattaggcgc 92220

gactattaca gccttattat atattcctgc aatgtttatg ataatgagaa aggttaagta 92280

ctagaacaac tttccgagca ataatttctt cctagctttt ttacaataag tgattcatga 92340

gtataggtct cgcaagaatc acatttaatc atagagttat caatcttttt tttatgaggt 92400

cctgatatga gagatctgaa aaagaatacc gcagttatta tcaatataaa tatgaccaat 92460

ggaatcaaaa gtaatatcga ttttaataag aacatttttt agtcactaga tgctggctta 92520

ctatttctta taaaattcca agaccagcca gacttatctt cagatttttt tgattgctca 92580

tcttggtagt taatagaaat tatttttta gtatcttcaa gcaattcaat atatcccaaa 92640

gattcatatg aagcctctaa gatcttaaga gctctataat tttcactaga gttaggaata 92700

ttttcaatta cataatttgc tcttcttatt gctgctatat gcgcatcaac actaacgtaa 92760

taatcagctg ccgcaagctc atttcttgca atcatatttc ttaaatagat atttctttgt 92820

ttagcatatg tagaatattg gctatcagga aatcttgtta agaattcagt tagttctgaa 92880

aatgattcct tagctcctga gatatctcta tttgatagat cagtatctgt cattcttaca 92940

ataaagctat tatctctcgt atagctagaa aggcctttca taaaatatgc ataatcaata 93000

tttggatgcc taggatgaag tcttataaat ttttctgctg cagcatgcgc agcctcagtt 93060

tcagcattca taaattgagc ataaataagc tctacttgcg cctgttcagc atatttgcca 93120

aaaggatatc ttgattcaat tgcttctaat gaatcaatag caccaaaata atttttttcca 93180

gccatccttc tttgggcttg atcgtaataa atttttttcag gctgttctat ttctgggcca 93240

tcagaattac aactaaccaa taacagagtt acaattggca atactataaa tagttttaaa 93300

attagtttat ctttcattat ttgcacattc tacctgcatt atcgtaattt aagcttgaaa 93360

acatctattt agattaattt ttttataata agttcatatg attgttaaaa atgttccaaa 93420

tgatctatct tcaatgaggc tagacaaagc tacagcagaa atgtttacag attattccag 93480

aactcagata aaaaaatgga tagaagaagg cagagttctt ataaatggag aggtatccca 93540

gccaagagat aaagtttatg agaatgatca gattgaatta agccctaaag aagaacaaaa 93600

agtatcatgg gaagctcaag atatagattt tgaaattcac tttgaaaatg aagattttat 93660

tataattaat aaacctgctg gtttaataat gcatccaggt tctggttgct atgatggaac 93720

tctcgcaaat gggctcattt ataaatttcc agaattgatc aatattccaa ggtcgggaat 93780

tgttcatcga ttagacaaag atacttctgg cattctgctc gtagcaagaa atgagtcttt 93840

taggaacttt tttattaatg aaatgcagga gaggagagtt gtaaaaaaat atacgtctat 93900

tgttattggt tctacactag gaagcttttc tatagaagag ccaattggaa gagataaaaa 93960

taatagaacc aaaatggcaa ttcgagaaga tggcaaagat gctttaacat ttgtaaagct 94020

taaagaaaat attggaaact actctgtgtt ggatataaga atagagacag gaagaactca 94080

tcagattagg gtccatctat catcaaaaaa actaccaata attggagata aaacctatga 94140

cccaagcagg tctattgcaa gagatacccc tgaagagcta attaatatta tccgaggttt 94200

tccaaggcag gcattacatg caacacacct ctcattcaat gaccaaaaaa caaataatat 94260

tttttctttt gatattccca ctccaaatga tatggaggaa ctacttctag aattaagaaa 94320

attgatctaa tagtaactaa aaacttgttt tttgattaat aaaataatat aaaccttatt 94380

cctaagagtt ttttggtaag aaattgaaat tatctggcgc agacatgcta atgcaagcac 94440

ttcatgatga aggtgttgag ctaatctttg gctacccagg tggagccgcg cttcatatct 94500

atgatgcaat ttttagacaa gataaaatag atcatatttt agtaaggcat gagcaaggtg 94560

caacccatgc agcagatgga tattcaaggg cgacaggtaa gccaggagtt gtcttagtca 94620

cttctggacc tggtgcaaca aatgctatta caggaatcgc gactgcattt atggattcca 94680

taccaatggt agttatttca gggcaggttg ctagccattt aataggtact gatgcttttc 94740

aagaaactga tatgattggt gtttcaagac caattgttaa gcatagctat acagttttta 94800

atgctgaaga aatacctaag ataattaaag aagcttttta tgtcgcaact tcaggcagac 94860

ctggacctgt tgttatagat atcccaaaag acatgacagc tccggataat ctttttgatt 94920

actcgtatcc tgaagaagcc aagataagat catacaatcc tccgattgag ccagaaaaaa 94980

atcaaataga tagagcagtc gaagctatat tgatatcaaa aaaaccagtt atatatgctg 95040

gtggtggggc aattgctagt aatgccgaaa aagaattact tgaacttaat gaaattattg 95100

atgctcctgt tacaaatact ttaatgggat tgggtattta ccctgctagt catcatagat 95160

ttcttgggat gttagggatg catggaacat atcaggcaaa tatggcaatg cataatgcag 95220

acttaataat tgctattggc gccagatttg atgacaggat taccaataaa ccatcaaagt 95280

ttgcacctaa tgccaaagtg gttcatctag atgttgatca ctcatctgta tcaaaaatta 95340

tagaagcaaa tgtagctgtt tttgggcaag taaaaaattc cttaaaatta ataaaagaaa 95400

ctcttgaaaa aaaattagac tcttacgatt ctttcgctct tcagccttgg cacgatcaga 95460

taaaagaatg gaaatcacta catggtttaa attatgagct ttataaagat gaatctgatg 95520

atcatcccat tttaccccag gctgtagtcc agcatgtcca tgagattaca aatggggaag 95580

catatgtgac ttccgatgtt ggtcagcatc aaatgtttgc tgctcaatat tatcattttg 95640

ataagcctag aagatggatc aattctggtg gtctaggaac tatgggtttt ggtttgccag 95700

cagcaatggg tgtaaaactc gcttttccaa aagatgaggt tgtttgcatt actggtgagg 95760

gtagtatcca aatgtgcatc caagaattgt ctacatgtct tcaatataat ctcccaataa 95820

aaataattaa tatcaataac gaagctcttg gtatggttaa acaatggcag gatatgaatt 95880

atggaggaag gcactctgaa agtacctatc aaaactcgtt accggatttt ataaaactgg 95940

ctgaatcata tggtcatata ggaattaaaa ttacaaaaaa ttctgattta agtgaaggct 96000

taaaaaaagc ttttgaaatg aaagataaac ttgtctttgt tgatatttat gtagatcctt 96060

cagagcatgt ttatccaatg caggttgcaa atggcagcct agaaaatatg tggctatcaa 96120

aggatgaaca aacatgatta aaagaaaact aattttaatt atggaaaata aaccaggagc 96180

tctagtaaga gtagttggac tgtttcatca aagaggctac aacattgaaa cccttcatgt 96240

agatactgtt aaagactttt ctacttacaa atcgatattg aaaaaaaact tgaaaccaaa 96300

tttgaggata atcaaatatc tagactgacc atagaaacaa tggtttcaga tgaccttatg 96360

aggcagattt tgagacagct caataaatta atagatgtta tagctgtaag caatgaagag 96420

acaacctatt taaaaggagt attattagat gaaaatttat tatgacgaag atgcaaacat 96480

agaaattatt aaagggatga atgtctcaat aattggctat ggatctcaag ggaatgctca 96540

tgcaaataat cttcatgaat ctggtgtaag tgttactgta ggtttaagag aagggtcttc 96600

ttcatgggca aaggcagaag aagcaggctt aaaagttcaa acagttgctg attcggtaat 96660

ccaagcagat ttggttatga ttttggcacc agatgaattc caaaaaaata tatatgaaac 96720

cgaaatcaag ccaaacttaa aaaccagtgc aattcttgca tttgcacatg gctttaatat 96780

tcattttgaa aaaatagttc ctgaagcaac taacagcgta attatgattg caccaaaagg 96840

tccaggccat actgttagaa gtacttatac caatggtgga ggcgttccat ctctcatagc 96900

tatatatgaa gatgctttaa gtgatgaaga ttattcagca aaagatgtag ctctatctta 96960

tgcaaaagca aatggcggca cgagggctgg tgttcttgaa acatctttta aagaagaaac 97020

agaaacagat ttatttggcg aacaagcagt tttatgtggc gggcttaccg ctttaattaa 97080

agctgggttt gaaactctag ttgaggcagg ctacagtgaa gagatggcat attttgaatg 97140

ccttcatgaa acaaaactaa tcacagactt aattcaagaa ggtggcattg ctaatatgca 97200

ttactcaata tcaaatactg ctgagtatgg tgattatgtg agtggaccca aagtaattac 97260

tagcgatacc aaaaaagcaa tgaaaggaat actagaaaat atacagtcag gaaaattcgc 97320

agatgacttc ttgaatgact gtcgacaaag caatgatggc actggcggac ctgttatgaa 97380

aagcaataga gaagctacaa aaattcatcc aatagagtcg gtaggggctg agctaaggtc 97440

taaaatgaag ttcctaaatt cacaaaaatt ggtggataaa gaaattaatt aaaattaatt 97500

aaaaaaaagg tatcttcttc ggaataactt cgttaagata cgcgtccgca caaagaggcg 97560

gttgttcttt aaaaatattt ggttactcgt gtgggtgttc aaaatacgag aaaaaataat 97620

ttagattttt tataaaaatc aacaaaacat gatattaatt gaagagtttg atcatggctc 97680

agattgaacg ctggcggtag gcttaacaca tgcaagtcgt gcgagaaagt atcttcggat 97740

atgagtagag cggcggacgg gtgagtaacg cgtaggaatc tacctagtag aaggggatag 97800

cccggggaaa cccggattaa taccgtatac ctccttcggg agaaagaagg cctctctttg 97860

aagctttcgc tactagatga gcctgcgtaa gattagcttg ttggtgaggt aaaggctcac 97920

caaggcgacg atctttagct ggtctgagag gacgatcagc cacattggga ctgagacacg 97980

gcccagactc ctacgggagg cagcagtggg gaatattgga caatgggcgc aagcctgatc 98040

cagccatacc gcgtgtgtga agaaggcctt cgggttgtaa agcactttaa gcagggagaa 98100

aaagttataa gttaatacct tataaccctg atgttacctg cagaataagc accggctaat 98160

tccgtgccag cagccgcggt aatacggaag gtgcaagcgt taatcggaat tactgggcgt 98220

aaagcgcgcg taggtggttt gttaagttgg atgtgaaagc cctgggctca acctaggaac 98280

tgcatccaaa actaactcac tagagtacga tagagggagg tagaattcat agtgtagcgg 98340

tggaatgcgt agatattatg aagaatacca gtggcgaagg cggcctcctg gatctgtact 98400

gacactgagg tgcgaaagcg tgggtagcga acaggattag ataccctggt agtccacgcc 98460

gtaaacgatg acaactagct gttgggagac tatgtctttc agtggcgcag ctaacgcttt 98520

aagttgtccg cctggggagt acggccgcaa ggctaaaact caaatgaatt gacgggacc 98580

cgcacaagcg gtggagcatg tggtttaatt cgatgcaacg cgaaaaacct tacctactct 98640

tgacatactt ggaggctctt gtaatgagag tgtgcctttt ggaaccaaga tacaggtgct 98700

gcatggctgt cgtcagctcg tgtcgtgaga tgttccgtta agtcggataa cgagcgcaac 98760

ccttaccctt atttgccagc gattcggtcg ggaactataa ggggactgcc ggtgataaac 98820

cggaggaagg tgaggacgac gtcaagtcat catggccctt acgagtaggg ctacacacgt 98880

gctacaatgg gagatacaga cggacgctaa gccgcgaggt ggtgctaatc ctaaaaagtc 98940

tttcgtagtc cggattggag tctgcaactc gactccatga agtcggaatc gctagtaatc 99000

gcggatcagc atgccgcggt gaatacgttc tcgggtcttg tacacaccgc ccgtcacacc 99060

atggaagtgg attgcaccag aagtagatag tctaacctta gggagggcgt ttaccacggt 99120

gtgcttcatg actggggtga agtcgtaaca aggtagccgt aggggaacct gtggctggat 99180

cacctcctta acgataaatc gcgttttaaa cgcccacacg agtaatcaaa tattaaaaaa 99240

aagaacattt agatatgtaa aatcattggt atgtaatttt ctagtgtata catttatgta 99300

tacataagat cactgcaatt aaaaagtaac atatgcattt atgtgtatgt taaaaaagta 99360

attaatatat tttattaagt tactctcaaa aatgaagata aaacttcaaa aaaaatatgt 99420

aacctttttt aaggttatat gatcaagtaa aggaagagca caaggcggat gccttggcag 99480

cataaggcga tgaaggacgt aataacctgc gataagcctc ggggagctgg taaataagct 99540

tcgatccgag gatttccgaa tgggaaaacc caatacacat aagtgtatta tcttatactg 99600

aatacatagg tataagaggc aaacctaggg aactgaaaca tctaagtacc tagaggaaaa 99660

gaaatcaaca gagattccgg tagtagcggc gagcgaaacc ggaccagccc ttaagcttat 99720

tttagtccag caaaatattc tggaaagttt agccatagta ggtgatagcc ctgtatgcga 99780

aagactaatt taagtgaaat cgagtaggtc gggacacgag aaatcttgac tgaacatggg 99840

gggaccatcc tccaaggcta aatactctat gctgaccgat agtgaaccag taccgtgagg 99900

gaaaggcgaa aagaaccccg gcgaggggag tgaaatagaa cctgaaacct tgtgcttaca 99960

agcagtcgga gcagacttgt tctgtgacgg cgtacctttt gtataatggg tcaacgactt 100020

aatttcagta gcaagcttaa ccatttaggg taggcgtagg gaaaccgagt cttaataggg 100080

cgctcagttg ctggaattag acccgaaacc gggtgatcta tccatggcca gtgtgaaggt 100140

cgagtaacat cgactggagg cgcgaaccca cttatgttga aaaatgaggg gatgagctgt 100200

ggataggagt gaaaggctaa tcaaacccgg agatagctgg ttctcttcga aaactattta 100260

ggtagtgcct cgtgtattac tgtagggggt agagcactgt ttcggctagg gggtcatccc 100320

gacttaccaa accgatgcaa actccgaata cctacaagta tgagcacggg agacagactg 100380

cgggtgctaa cgtccgtagt cgagagggaa acaacccaga ctgtcagcta aggtcccaaa 100440

ttatgattaa gtgggaaaca atgtgggaag gcacaaacag ctaggaggtt ggcttagaag 100500

cagccatcct ttaaagaaag cgtaatagct cactagtcga gtcggcctgc gtggaagata 100560

taacggggct aaatcataaa ccgaagctac agatcttaaa tttatttaag atggtagaag 100620

agcgttctgt aagcggttga aggtaagctg agaggcgaac tggacgtatc agaagtgcga 100680

atgttgacat gagtaacgat caaagaggtg aaaaacctct tcgccgaaaa accaagggtt 100740

cctgtccaac gctaatcgag gcagggtgag gcggccccta aggcgagggc gaaagccgta 100800

gtcgatggga aacaggttaa tattcctgta ctttttataa ctgcgatggg gtgacggaga 100860

aggttagact agcacggcga cggttgtccg tgttcaaggt tgtaggctgg tgttctaggt 100920

aaatccggaa cgctaaggct gagaactgat aacgaccact ctacgagtgg gaagtagtcg 100980

ataccatgct tccaggaaaa acctctaagc ttcaggttat aagaaaccgt accctaaacc 101040

gacacaggtg gttaggtcga gtagaccaag gtgtttgaga gaactatggt gaaggaacta 101100

ggcaaaatag caccgtaact tcgggagaag gtgcgccgcg tttggtgatg agacttgctc 101160

tctaagctga acgtggtcga agataccagg tggctgcgac tgtttactaa aaacatagca 101220

ctctgcaaac tcgtaagagg aagtataggg tgtgacgcct gcccggtgcc ggaaggttaa 101280

ttgatggggt tagcttatgc gaagctcttg atcgaagccc cggtaaacgg cggccgtaac 101340

tataacggtc ctaaggtagc gaaattcctt gtcgggtaag ttccgacctg cacgaatggc 101400

gtaacgatgg ccacactgtc tccaccatag actcagtgaa attgaaatcg ctgttaagat 101460

gcagtgtacc cgcagctaga cggaaagacc ccgtgcacct ttactatagg ttcgcactgg 101520

actttgacct tacttgtgta ggataggtgg gagactttga agcagagacg ccagtctttg 101580

tggagtcatc cttgaaatac caccttgta agattgaagt tctaacctag gtccattatc 101640

tggatcaggg acagtgcgtg ctgggtagtt tgactggggc ggtctcctcc taaagagtaa 101700

cggaggagta cgaaggtatc cttatcacgg tcggacatcg tgaggtaagt ataaaggcag 101760

aaggatgctt gactgcgaga tcgacggatc gagcaggtag gaaactaggt cttagtgatc 101820

cggtggttct gaatggaagg gccatcgctc aacggataaa aggtacgccg gggataacag 101880

gctgataccg cccaagagtt catatcgacg gcggtgtttg gcacctcgat gtcggctcat 101940

cacatcctgg ggctggagca ggtcccaagg gtatggctgt tcgccattta aagtggtacg 102000

cgagctgggt ttagaacgtc gtgagacagt tcggtcccta tctgctgtgg gcgtttggag 102060

atttgaggga agctgattct agtacgagag gaccgaattg gacgaacctc tggtgttccg 102120

gttgtcacgc cagtggcatt gccgggtagc tatgttcgga aaggataacc gctgaaagca 102180

tataagcggg aagcctctcc caagattaaa tctcccagag actttatgtc tcctaaagag 102240

tcgtcataga ctatgacgtt gataggcaag atgtgtaagc gctgcgaggc gttgagctaa 102300

cttgtactaa taactcgtga ggcttgatca tgtaacctta agcaaggttc ataatttgag 102360

taaaacattg tagtgagaat taaaaaataa aaagttacat accagtttgc ctgatgacaa 102420

tagcaacttg gaaccacctg atcccatctc gaactcagaa gtgaaacgag ttaacgccaa 102480

tggtagtgca gggtctccct gtgtgagagt aggaaatcgt caggcttttt tctttaaggc 102540

ttccagttta ctggaagcct ttttttttat ctcaagtata atacccagat gattattgga 102600

ttaacaggag gcattggttc tggcaaatct gccgctgcag acttctttat tgatttaggt 102660

atatcagtct tagatgcaga tcaagttgct aaagaagctt tatctacaaa ttctcctgga 102720

tatactgatt ttatttctca atttggtgaa gtgtatttaa ataataatcg tgaggttgat 102780

aggctgaaat tgcgcgaact tatttttca aatccttcaa aaaaaaagga tcttgagaat 102840

attattcatc ccatagttcg gtctgctatt agtaatttta ttattacatc aacatcacca 102900

tattctattg ttatggtgcc actcattttt gaaacaaatt catataaaaa ttacgataag 102960

attattactg ttgactgtga tttagaactt cagatagtaa gggcctcaag tagagatgct 103020

caaaataaat cgcagattaa gaatattatt aataagcaag cctctagaga ggagaggcta 103080

agtatttctg atgacgtact tatcaataac agcaccctat ctgatctaaa aaaacaagtt 103140

aatgttttac atactaaata tatggagtta ttaaatgagt agttgcccta gatgtgaaaa 103200

acctgtcaaa ctttctactg acaatattta tagacctttc tgctctgaga aatgcaaact 103260

tatagatttt ggtgattggg ctaatgaaga taataaaatt tcaagaccaa ttcaatctga 103320

agatttttac gaagattaaa tttaagaaag tctccattca ccactttcaa tcatcggttt 103380

ggctttttta tacttcattt cttgcgtatc ttgaccgtta gtaattttta caagatcatt 103440

tctgcctaac ttaggttcgt ttcttgtcac agtacttgtt tttactatag gagtggcttg 103500

tttttcattt tgaaagatat cagaattaat ttcctctttt tccaatttta attcttgaga 103560

actattttgt ttgtttatgc tctctagctc agattctgtc gatatttgta atgagaaaag 103620

tattcttata gtttcaacat ctatttccga aagcatagat tcaaacattg aatatgcctc 103680

tcttttgaat tcatttttg gatttttttg agcataagcc cttagaccaa cactatttct 103740

taaatgatct atttctgata aatgctcttt ccaatggaca tcaagtactt gcagcataac 103800

ctgcttctca agaagcaatc tattttcacc aagatcacta aacttttttg aatatttatt 103860

ttttgcttgc agaacaattt cttcggcaat tgtatttggt acaagttttt tattactatt 103920

aattttattg gctatatctg tttctagtcc atagctctct tttaaataat catcgagctg 103980

cctacttttc cattgagact ctattgattc ttcaggtaca tataaattag atattccttt 104040

gaattgctgc tcgatgagtg actcaatggt actgctaata tcttcctctt ctagtaattg 104100

attccttaaa gaatatatag cttgtctttg atcatttgat acatcgtcgt actctaaaag 104160

attttcctt gcatcaaagt ttctgctctc aattcttttt tgcgcatttt ctattcctct 104220

tgaaagcatt ttagcttcaa tatgatcatc tcccatgccc agcctttcaa aagtagccct 104280

tcttccatcc gaaataaaaa gtctcaagag atcgtcttct aaagataaga agaattttga 104340

ataacctgga tcaccttgtc tgcctgatct ccccccttaac tgattatcta ttcttcttga 104400

ttcatgcctt tctgttccaa gtatatgaag cccaccagat tctataactt ttttattatt 104460

ttctttccac tctatatcgc tttggtcttc ttttttttccg ccaagaacta tatccgtccc 104520

ccttcctgcc atattcgtag caatagttac cattccaggt ttacctgcat tggcaattat 104580

ctctgcttct ttttcgtgat gcttggcatt taaaatttga tgaggtattt ttttgttatt 104640

taaatatgct gatacttctt ctgaagattc aaccgaaact gttccaacaa gaatgggaga 104700

agatttttt cttaattgtt caatttcttc aattagagct ttatatttcg attctgttgt 104760

aagaaatact aagtcattaa gatcagctct agccatagga acatttgttg ggatgatgat 104820

gacatttagg ccatagattt gactaaactc tactgcttca gtatctgctg ttcctgtcat 104880

cccagaaagt tttttaaata atctaaaaaa gttttggaat gtggtggatg ctagtgtttg 104940

agactctctt tggatagcaa cattttcttt gcattccagt gcctggtgaa caccttcact 105000

cattcttctt ccgggcattg ttctacctgt atgctcatca atcaaaagaa cctcaccgtt 105060

cctaaccaaa taatccacat tcttttttaaa taagaagctt gctctaagtg ttgcttgaac 105120

aaatttcata atttttaaat tagaaacaga gtaagcccat ctgaggctcc aagccgattc 105180

cagc 105184

# CLAIMS

What is claimed is:

1. A proteorhodopsin gene, comprising an isolated DNA sequence for encoding a proteorhodopsin protein.

2. The proteorhodopsin gene of claim 1, wherein said proteorhodopsin gene is retrieved from a genomic fragment of a sample of naturally occurring bacteria.

3. The proteorhodopsin gene of claim 2, wherein said naturally occurring bacteria are marine proteobacteria.

4. The proteorhodopsin gene of claim 2, wherein said naturally occurring bacteria are SAR86 bacteria.

5. The proteorhodopsin gene of claim 2, wherein said naturally occurring bacterial genomic fragment is retrieved from a recombinant DNA library.

6. The proteorhodopsin gene of claim 5, wherein said naturally occurring bacterial genomic fragment is retrieved from a bacterial artificial chromosome library.

7. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone BAC31A8, said proteorhodopsin gene is Sequence ID No:4 and said proteorhodopsin protein is Sequence ID No:5.

8. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone BAC40E8, said proteorhodopsin gene is Sequence ID No:8 and said proteorhodopsin protein is Sequence ID No:9.

9. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone BAC41B4, said proteorhodopsin gene is Sequence ID No:10 and said proteorhodopsin protein is Sequence ID No:11.

10. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone BAC64A5, said proteorhodopsin gene is Sequence ID No:12 and said proteorhodopsin protein is Sequence ID No:13.

11. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone HOT0m1, said proteorhodopsin gene is Sequence ID No:14 and said proteorhodopsin protein is Sequence ID No:15.

12. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone HOT75m1, said proteorhodopsin gene is Sequence ID No:16 and said proteorhodopsin protein is Sequence ID No:17.

13. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone HOT75m3, said proteorhodopsin gene is Sequence ID No:18 and said proteorhodopsin protein is Sequence ID No:19.

14. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone HOT75m4, said proteorhodopsin gene is Sequence ID No:20 and said proteorhodopsin protein is Sequence ID No:21.

15. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone HOT75m8, said proteorhodopsin gene is Sequence ID No:22 and said proteorhodopsin protein is Sequence ID No:23.

16. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB0m1, said proteorhodopsin gene is Sequence ID No:24 and said proteorhodopsin protein is Sequence ID No:25.

17. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB0m2, said proteorhodopsin gene is Sequence ID No:26 and said proteorhodopsin protein is Sequence ID No:27.

18. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB20m2, said proteorhodopsin gene is Sequence ID No:28 and said proteorhodopsin protein is Sequence ID No:29.

19. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB20m5, said proteorhodopsin gene is Sequence ID No:30 and said proteorhodopsin protein is Sequence ID No:31.

20. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB20m12, said proteorhodopsin gene is Sequence ID No:32 and said proteorhodopsin protein is Sequence ID No:33.

21. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB40m1, said proteorhodopsin gene is Sequence ID No:34 and said proteorhodopsin protein is Sequence ID No:35.

22. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB40m5, said proteorhodopsin gene is Sequence ID No:36 and said proteorhodopsin protein is Sequence ID No:37.

23. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB40m12, said proteorhodopsin gene is Sequence ID No:38 and said proteorhodopsin protein is Sequence ID No:39.

24. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB100m5, said proteorhodopsin gene is Sequence ID No:40 and said proteorhodopsin protein is Sequence ID No:41.

25. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB100m7, said proteorhodopsin gene is Sequence ID No:42 and said proteorhodopsin protein is Sequence ID No:43.

26. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB100m9, said proteorhodopsin gene is Sequence ID No:44 and said proteorhodopsin protein is Sequence ID No:45.

27. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone MB100m10, said proteorhodopsin gene is Sequence ID No:46 and said proteorhodopsin protein is Sequence ID No:47.

28. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB1, said proteorhodopsin gene is Sequence ID No:48 and said proteorhodopsin protein is Sequence ID No:49.

29. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB2, said proteorhodopsin gene is Sequence ID No:50 and said proteorhodopsin protein is Sequence ID No:51.

30. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB5, said proteorhodopsin gene is Sequence ID No:52 and said proteorhodopsin protein is Sequence ID No:53.

31. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB7, said proteorhodopsin gene is Sequence ID No:54 and said proteorhodopsin protein is Sequence ID No:55.

32. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB6, said proteorhodopsin gene is Sequence ID No:56 and said proteorhodopsin protein is Sequence ID No:57.

33. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALB8, said proteorhodopsin gene is Sequence ID No:58 and said proteorhodopsin protein is Sequence ID No:59.

34. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALE1, said proteorhodopsin gene is Sequence ID No:60 and said proteorhodopsin protein is Sequence ID No:61.

35. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALE6, said proteorhodopsin gene is Sequence ID No:62 and said proteorhodopsin protein is Sequence ID No:63.

36. The proteorhodopsin gene of claim 2, wherein said genomic fragment is retrieved from a clone PALE7, said proteorhodopsin gene is Sequence ID No:64 and said proteorhodopsin protein is Sequence ID No:65.

37. The proteorhodopsin gene of claim 1, wherein said proteorhodopsin gene is amplified from a genomic fragment by polymerase chain reaction.

38. The proteorhodopsin gene of claim 37, wherein said polymerase chain reaction is performed by primers with Sequence ID No:2 and Sequence ID No:3.

39. The proteorhodopsin gene of claim 1, wherein said proteorhodopsin gene is derived from a marine environment and placed in an expression vector for producing said proteorhodopsin protein in a host.

40. The proteorhodopsin gene of claim 39, wherein said host is an artificial membrane system.

41. The proteorhodopsin gene of claim 39, wherein said host is a bacterium.

42. The proteorhodopsin gene of claim 41, wherein said host is a cell membrane preparation of said bacterium.

43. The proteorhodopsin gene of claim 39, wherein said host is an eukaryote.

44. The proteorhodopsin gene of claim 43, wherein said host is a cell membrane preparation of said eukaryote.

45. A method of retrieving a proteorhodopsin gene, comprising the steps of:

(a) providing a sample of naturally occurring bacteria;

(b) extracting a genomic fragment of said sample of naturally occurring bacteria; and

(c) amplifying said proteorhodopsin gene from said genomic fragment using polymerase chain reaction.

46. The method of claim 45, further comprising the step of creating an expression vector containing said proteorhodopsin gene.

47. The method of claim 45, wherein said naturally occurring bacteria are marine proteobacteria.

48. The method of claim 45, wherein said naturally occurring bacteria are SAR86 bacteria.

49. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is retrieved from a recombinant DNA library.

50. The method of claim 49, said naturally occurring bacterial genomic fragment is retrieved from a bacterial artificial chromosome library.

51. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone BAC31A8, and wherein said amplified

proteorhodopsin gene from said clone BAC31A8 is Sequence ID No:4 and encodes a proteorhodopsin protein according to Sequence ID No:5.

52. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone BAC40E8, and wherein said amplified proteorhodopsin gene from said clone BAC40E8 is Sequence ID No:8 and encodes a proteorhodopsin protein according to Sequence ID No:9.

53. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone BAC41B4, and wherein said amplified proteorhodopsin gene from said clone BAC41B4 is Sequence ID No:10 and encodes a proteorhodopsin protein according to Sequence ID No:11.

54. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone BAC64A5, and wherein said amplified proteorhodopsin gene from said clone BAC64A5 is Sequence ID No:12 and encodes a proteorhodopsin protein according to Sequence ID No:13.

55. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone HOT0m1, and wherein said amplified proteorhodopsin gene from said clone HOT0m1 is Sequence ID No:14 and encodes a proteorhodopsin protein according to Sequence ID No:15.

56. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone HOT75m1, and wherein said amplified

proteorhodopsin gene from said clone HOT75m1 is Sequence ID No:16 and encodes a proteorhodopsin protein according to Sequence ID No:17.

57. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone HOT75m3, and wherein said amplified proteorhodopsin gene from said clone HOT75m3 is Sequence ID No:18 and encodes a proteorhodopsin protein according to Sequence ID No:19.

58. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone HOT75m4, and wherein said amplified proteorhodopsin gene from said clone HOT75m4 is Sequence ID No:20 and encodes a proteorhodopsin protein according to Sequence ID No:21.

59. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone HOT75m8, and wherein said amplified proteorhodopsin gene from said clone HOT75m8 is Sequence ID No:22 and encodes a proteorhodopsin protein according to Sequence ID No:23.

60. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB0m1, and wherein said amplified proteorhodopsin gene from said clone MB0m1 is Sequence ID No:24 and encodes a proteorhodopsin protein according to Sequence ID No:25.

61. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB0m2, and wherein said amplified

proteorhodopsin gene from said clone MB0m2 is Sequence ID No:26 and encodes a proteorhodopsin protein according to Sequence ID No:27.

62. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB20m2, and wherein said amplified proteorhodopsin gene from said clone MB20m2 is Sequence ID No:28 and encodes a proteorhodopsin protein according to Sequence ID No:29.

63. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB20m5, and wherein said amplified proteorhodopsin gene from said clone MB20m5 is Sequence ID No:30 and encodes a proteorhodopsin protein according to Sequence ID No:31.

64. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB20m12, and wherein said amplified proteorhodopsin gene from said clone MB20m12 is Sequence ID No:32 and encodes a proteorhodopsin protein according to Sequence ID No:33.

65. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB40m1, and wherein said amplified proteorhodopsin gene from said clone MB40m1 is Sequence ID No:34 and encodes a proteorhodopsin protein according to Sequence ID No:35.

66. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB40m5, and wherein said amplified

proteorhodopsin gene from said clone MB40m5 is Sequence ID No:36 and encodes a proteorhodopsin protein according to Sequence ID No:37.

67. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB40m12, and wherein said amplified proteorhodopsin gene from said clone MB40m12 is Sequence ID No:38 and encodes a proteorhodopsin protein according to Sequence ID No:39.

68. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB100m5, and wherein said amplified proteorhodopsin gene from said clone MB100m5 is Sequence ID No:40 and encodes a proteorhodopsin protein according to Sequence ID No:41.

69. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB100m7, and wherein said amplified proteorhodopsin gene from said clone MB100m7 is Sequence ID No:42 and encodes a proteorhodopsin protein according to Sequence ID No:43.

70. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB100m9, and wherein said amplified proteorhodopsin gene from said clone MB100m9 is Sequence ID No:44 and encodes a proteorhodopsin protein according to Sequence ID No:45.

71. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone MB100m10, and wherein said amplified

proteorhodopsin gene from said clone MB100m10 is Sequence ID No:46 and encodes a proteorhodopsin protein according to Sequence ID No:47.

72. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB1, and wherein said amplified proteorhodopsin gene from said clone PALB1is Sequence ID No:48 and encodes a proteorhodopsin protein according to Sequence ID No:49.

73. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB2, and wherein said amplified proteorhodopsin gene from said clone PALB2 is Sequence ID No:50 and encodes a proteorhodopsin protein according to Sequence ID No:51.

74. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB5, and wherein said amplified proteorhodopsin gene from said clone PALB5 is Sequence ID No:52 and encodes a proteorhodopsin protein according to Sequence ID No:53.

75. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB7, and wherein said amplified proteorhodopsin gene from said clone PALB7 is Sequence ID No:54 and encodes a proteorhodopsin protein according to Sequence ID No:55.

76. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB6, and wherein said amplified

proteorhodopsin gene from said clone PALB6 is Sequence ID No:56 and encodes a proteorhodopsin protein according to Sequence ID No:57.

77. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALB8, and wherein said amplified proteorhodopsin gene from said clone PALB8 is Sequence ID No:58 and encodes a proteorhodopsin protein according to Sequence ID No:59.

78. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALE1, and wherein said amplified proteorhodopsin gene from said clone PALE1 is Sequence ID No:60 and encodes a proteorhodopsin protein according to Sequence ID No:61.

79. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALE6, and wherein said amplified proteorhodopsin gene from said clone PALE6 is Sequence ID No:62 and encodes a proteorhodopsin protein according to Sequence ID No:63.

80. The method of claim 45, wherein said naturally occurring bacterial genomic fragment is in a clone PALE7, and wherein said amplified proteorhodopsin gene from said clone PALE7 is Sequence ID No:64 and encodes a proteorhodopsin protein according to Sequence ID No:65.

81. The method of claim 45, wherein said polymerase chain reaction is performed by primers with Sequence ID No:2 and Sequence ID No:3.

82. The method of claim 45, further comprising the step of providing a host.

83. The method of claim 82, wherein said host is an artificial membrane system.

84. The method of claim 82, wherein said host is a bacterium.

85. The method of claim 84, wherein said host is a cell membrane preparation of said bacterium.

86. The method of claim 82, wherein said host is an eukaryote.

87. The method of claim 86, wherein said host is a cell membrane preparation of said eukaryote.

88. A light-driven energy generator, comprising:

(a) a proteorhodopsin protein;

(b) a host to correctly fold said proteorhodopsin protein in said host, thereby creating an integrated proteorhodopsin protein; and

(c) a source of retinal to bind covalently to said integrated proteorhodopsin protein, thereby creating a light absorbing pigment.

89. The light-driven energy generator of claim 88, wherein said proteorhodopsin protein is encoded by a proteorhodopsin gene retrieved from a genomic fragment of a sample of naturally occurring bacteria.

90. The light-driven energy generator of claim 89, wherein said naturally occurring bacteria are marine proteobacteria.

91. The light-driven energy generator of claim 89, wherein said naturally occurring bacteria are SAR86 bacteria.

92. The light-driven energy generator of claim 89, wherein said naturally occurring bacterial genomic fragment is retrieved from a recombinant DNA library.

93. The light-driven energy generator of claim 92, wherein said naturally occurring bacterial genomic fragment is retrieved from a bacterial artificial chromosome library.

94. The light-driven energy generator of claim 89, wherein said genomic fragment is retrieved from a clone, wherein said clone is a member of the group consisting of BAC31A8, BAC40E8, BAC41B4, BAC64A5, HOT0m1, HOT75m1, HOT75m3, HOT75m4, HOT75m8, MB0m1, MB0m2, MB20m2, MB20m5, MB20m12, MB40m1, MB40m5, MB40m12, MB100m5, MB100m7, MB100m9, MB100m10, PALB1, PALB2, PALB5, PALB7, PALB6, PALB8, PALE1, PALE6 and PALE7.

95. The light-driven energy generator of claim 88, wherein said host is an artificial membrane system.

96. The light-driven energy generator of claim 88, wherein said host is a cell membrane obtained from a bacterium.

97. The light-driven energy generator of claim 96, wherein said host is a cell membrane preparation obtained from a bacterium.

98. The light-driven energy generator of claim 88, wherein said host is a cell membrane obtained from an eukaryote.

99. The light-driven energy generator of claim 98, wherein said host is a cell membrane preparation obtained from an eukaryote.

100. The light-driven energy generator of claim 88, further comprising a light source for illuminating said light absorbing pigment, whereby said energy generator converts light into biochemical energy.

101. The light-driven energy generator of claim 100, wherein said light source is a fast-pulsed light source.

102. The light-driven energy generator of claim 101, wherein said fast-pulsed light source comprises a mechanism for delivering intermittant fast-light pulses at predetermined time intervals.

103. The light-driven energy generator of claim 100, wherein said light source is a light source exhibiting different predetermined wavelengths.

104. The light-driven energy generator of claim 88, further comprising a mediator for mediating energy generated by said energy generator into chemical, mechanical or electrical energy.

105. The light-driven energy generator of claim 88, wherein said proteorhodopsin protein is selected to determine an absorption spectra of said light absorbing pigment.

106. A method for making a light-driven energy generator, comprising the steps of:

(a) providing a proteorhodopsin protein;

(b) providing a host to correctly fold said proteorhodopsin protein in said host, thereby creating an integrated proteorhodopsin protein; and

(c) providing a source of retinal to bind covalently to said integrated proteorhodopsin protein, thereby creating a light absorbing pigment.

107. The method of claim 106, wherein said proteorhodopsin protein is encoded by a proteorhodopsin gene retrieved from a genomic fragment of a sample of naturally occurring bacteria.

108. The method of claim 107, wherein said naturally occurring bacteria are marine proteobacteria.

109. The method of claim 107, wherein said naturally occurring bacteria are SAR86 bacteria.

110. The method of claim 107, wherein said naturally occurring bacterial genomic fragment is retrieved from a recombinant DNA library.

111. The method of claim 110, wherein said naturally occurring bacterial genomic fragment is retrieved from a bacterial artificial chromosome library.

112. The method of claim 107, wherein said genomic fragment is retrieved from a clone, wherein said clone is a member of the group consisting of BAC31A8, BAC40E8, BAC41B4, BAC64A5, HOT0m1, HOT75m1, HOT75m3, HOT75m4, HOT75m8, MB0m1, MB0m2, MB20m2, MB20m5, MB20m12, MB40m1, MB40m5, MB40m12, MB100m5, MB100m7, MB100m9, MB100m10, PALB1, PALB2, PALB5, PALB7, PALB6, PALB8, PALE1, PALE6 and PALE7.

113. The method of claim 106, wherein said host is an artificial membrane system.

114. The method of claim 106, wherein said host is a cell membrane obtained from a bacterium.

115. The method of claim 114, wherein said host is a cell membrane preparation obtained from a bacterium.

116. The method of claim 106, wherein said host is a cell membrane obtained from an eukaryote.

117. The method of claim 116, wherein said host is a cell membrane preparation obtained from an eukaryote.

118. The method of claim 106, further comprising the step of providing a light source for illuminating said light absorbing pigment, whereby said energy generator converts light into biochemical energy.

119. The method of claim 118, wherein said light source is a fast-pulsed light source.

120. The method of claim 119, wherein said fast-pulsed light source comprises a mechanism for delivering intermittant fast-light pulses at predetermined time intervals.

121. The method of claim 118, wherein said light source is a light source exhibiting different predetermined wavelengths.

122. The method of claim 106, further comprising the step of providing a mediator for mediating energy generated by said energy generator into chemical, mechanical or electrical energy.

123. The method of claim 106, wherein said proteorhodopsin protein is selected to determine an absorption spectra of said light absorbing pigment.

124. A PCR apparatus for amplifying a proteorhodopsin gene from DNA samples of naturally occurring microbial populations using polymerase chain reaction, comprising oligodeoxynucleotide primers with a Watson-Crick base pair complementarity to 5' and 3' ends of said proteorhodopsin gene.

125. The apparatus of claim 124, wherein said primers are according to Sequence ID No:2 and Sequence ID No:3.

126. A method of designing PCR primers, comprising the steps of:

(a) determining a DNA sequence of a proteorhodopsin gene; and

(b) based on said determined DNA sequence in (a), designing oligodeoxynucleotide primers with a Watson-Crick base pair complementarity to said 5' and 3' ends of said proteorhodopsin gene.

127. The method of claim 126, further comprising the step of using said oligodeoxynucleotide primers to amplify said proteorhodopsin gene from DNA samples of naturally occurring microbial populations by polymerase chain reaction.

128. The method of claim 127, further comprising the step of cloning said amplified proteorhodopsin gene into an expression vector.

129. The method of claim 126, wherein said primers are according to Sequence ID No:2 and Sequence ID No:3.

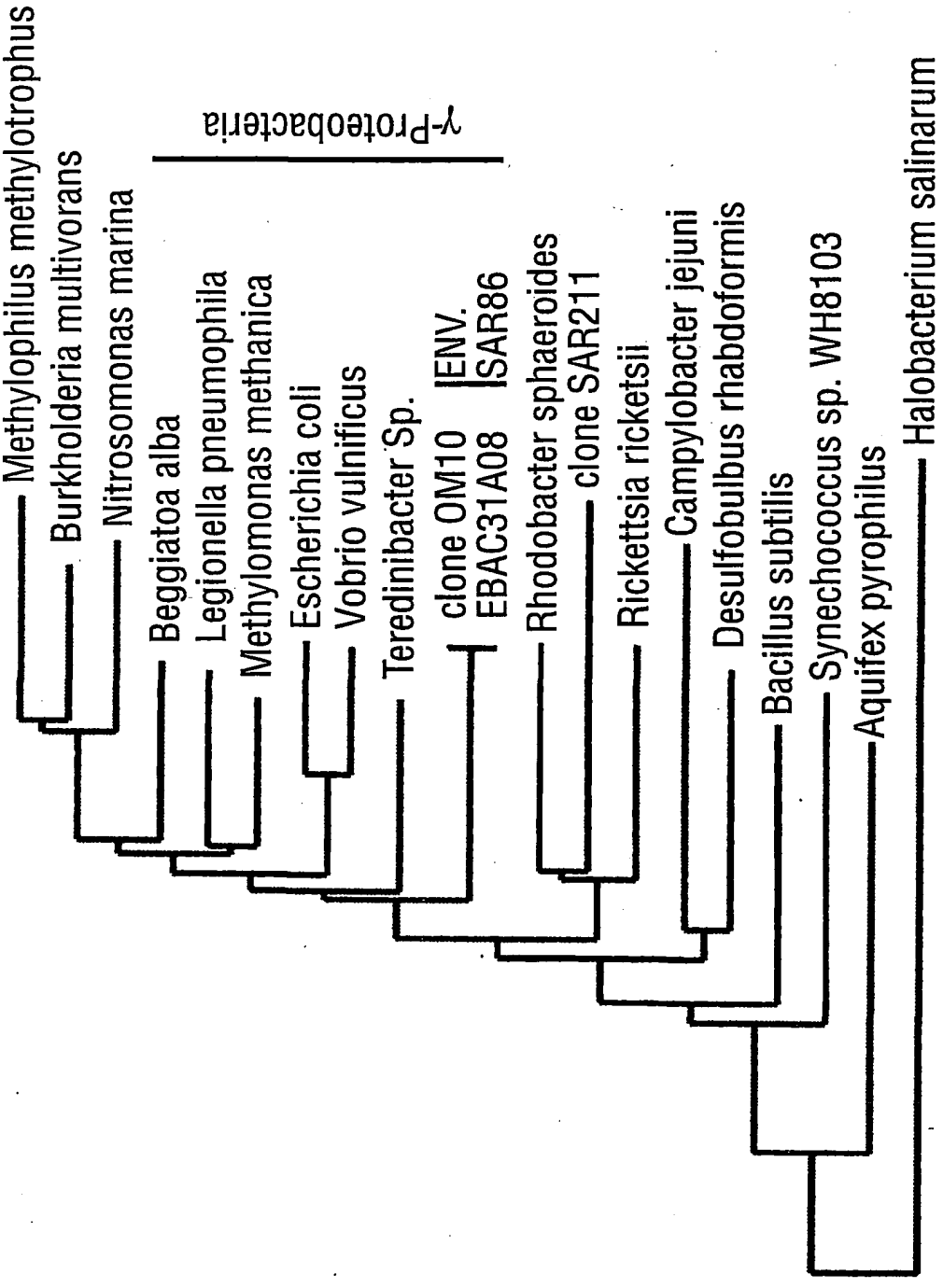

Methylophilus methylotrophus
Burkholderia multivorans
Nitrosomonas marina
Beggiatoa alba
Legionella pneumophila
Methylomonas methanica
Escherichia coli
Vobrio vulnificus
Teredinibacter Sp.
clone OM10
EBAC31A08
ENV.
SAR86
Rhodobacter sphaeroides
clone SAR211
Rickettsia ricketsii
Campylobacter jejuni
Desulfobulbus rhabdoformis
Bacillus subtilis
Synechococcus sp. WH8103
Aquifex pyrophilus
Halobacterium salinarum
γ-Proteobacteria

Fig. 1

accatgggta aattattact gatattagg 29

**Figure 2**

agcattagaa gattctttaa cagc 24

**Figure 3**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 4**

```
att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 4**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 4**

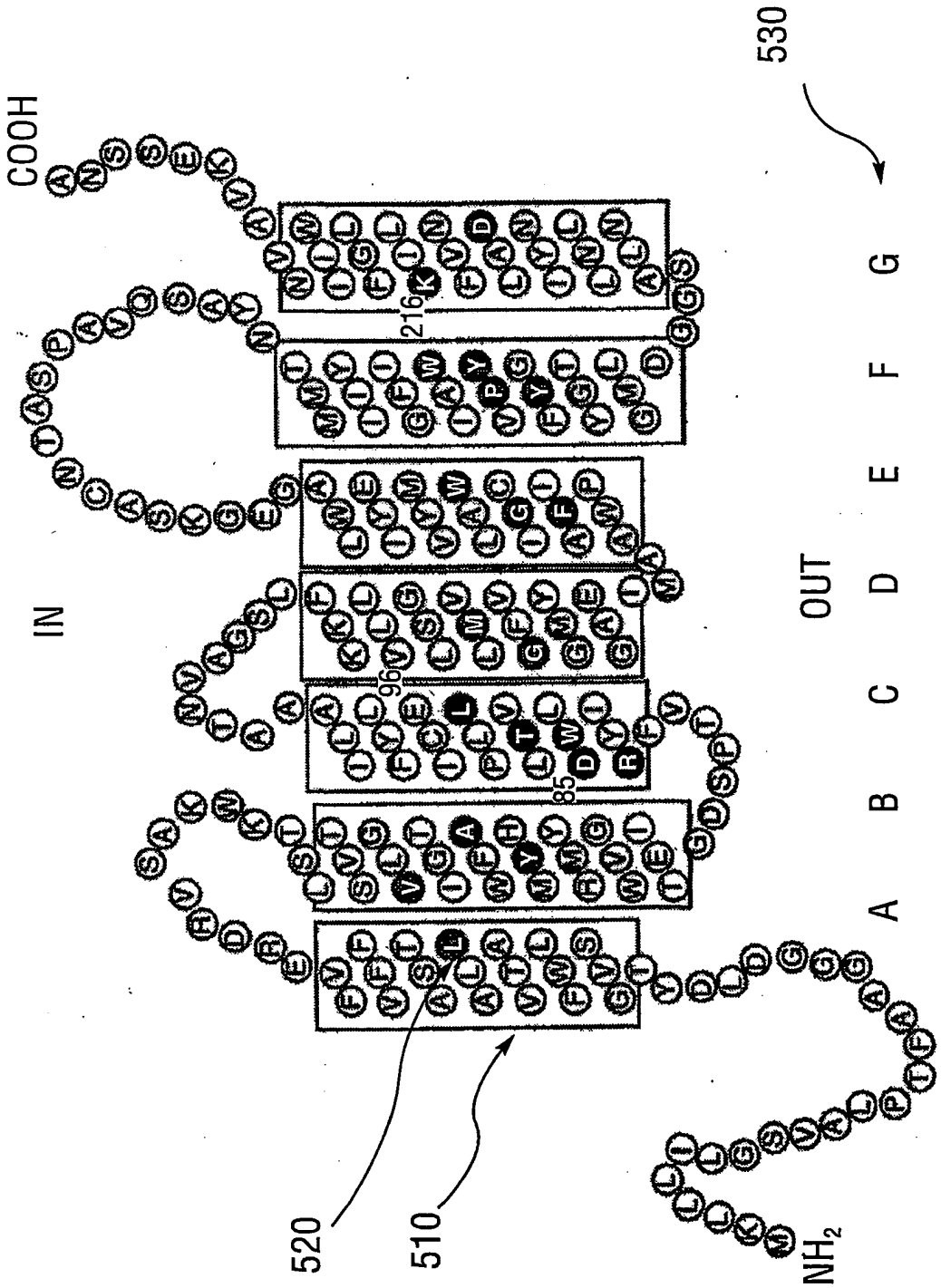



Fig. 5

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca        48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt        96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc       144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act       192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg       240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac       288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta       336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 6**

```
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 6**

```
gac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asp Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 6**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gct act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Ala Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 7**

```
att ctt gct gct gct act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 7**

```
aac ctt gct gat ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 7**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cct act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 8**

```
att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct ata ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Ile Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 8**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 8**

```
EBAC31A8     1  atgggtaaat tattactgat attaggTAGT GTTATTGCAC TTCCTACATT   50
  EBAC40     1  .......... .......... .......... .......... ..........   50
  EBAC41     1  .......... .......... .......... .......... ..........   50
  EBAC64     1  .......... .......... .......... .......... ..........   50

EBAC31A8    51  TGCTGCAGGT GGTGGTGACC TTGATGCTAG TGATTACACT GGTGTTTCTT  100
  EBAC40    51  .......... .......... .......... .......... ..........  100
  EBAC41    51  .......... .......... .......... .......... ..........  100
  EBAC64    51  .......... ..C....... .......... .......... ..........  100

EBAC31A8   101  TTTGGTTAGT TACTGCTGCT TTATTAGCAT CTACTGTATT TTTCTTTGTT  150
  EBAC40   101  .......... .......... C......... .......... ..........  150
  EBAC41   101  .........C .......... .......... .......... ..........  150
  EBAC64   101  .......... ...A...... C......... .......... ..........  150

EBAC31A8   151  GAAAGAGATA GAGTTTCTGC AAAATGGAAA ACATCATTAA CTGTATCTGG  200
  EBAC40   151  .......... .......... .......... .......... .......G..  200
  EBAC41   151  .......... .......... .......... .......... ..........  200
  EBAC64   151  .......... .......... .......... .......... ..........  200

EBAC31A8   201  TCTTGTTACT GGTATTGCTT TCTGGCATTA CATGTACATG AGAGGGGTAT  250
  EBAC40   201  .......... .......... .......... .......... ..........  250
  EBAC41   201  .......... .......... .......... .......... ..........  250
  EBAC64   201  .......... .......... .......... .......... .....A....  250

EBAC31A8   251  GGATTGAAAC TGGTGATTCG CCAACTGTAT TTAGATACAT TGATTGGTTA  300
  EBAC40   251  .......G.. .......... .......... .......... ..........  300
  EBAC41   251  .......... .......... .......... .......... ..........  300
  EBAC64   251  .......... .......... ..T....... .......... ..........  300
```

**Figure 9**

```
EBAC31A8  301  CTAACAGTTC CTCTATTAAT ATGTGAATTC TACTTAATTC TTGCTGCTGC  350
  EBAC40  301  .......... .......G.. .......... .......... ..........  350
  EBAC41  301  .......... .......... .......... .......... ..........  350
  EBAC64  301  .......... ..T....... .......... .......... ..........  350

EBAC31A8  351  AACTAATGTT GCTGGATCAT TATTTAAGAA ATTACTAGTT GGTTCTCTTG  400
  EBAC40  351  ...A...... ....CTGGCC .G........ ....T.G... ..........  400
  EBAC41  351  T......... .......... .......... .......... ..........  400
  EBAC64  351  .......... ..C..C.... .......... .C.T...... ..........  400

EBAC31A8  401  TTATGCTTGT GTTTGGTTAC ATGGGTGAAG CAGGAATCAT GGCTGCATGG  450
  EBAC40  401  .......... .......... ........G. .......T.. .AAC..T...  450
  EBAC41  401  .......... .......... .......... .......... ..........  450
  EBAC64  401  .......... .......... .......... .......T.. ...A..T...  450

EBAC31A8  451  CCTGCATTCA TTATTGGGTG TTTAGCTTGG GTATACATGA TTTATGAATT  500
  EBAC40  451  GG.......G .......... .......... .......... ........C.  500
  EBAC41  451  .......... .......... .......... .......... ........C.  500
  EBAC64  451  .......... .......... .......... .......... ........C.  500

EBAC31A8  501  ATGGGCTGGA GAAGGAAAAT CTGCATGTAA TACTGCAAGT CCTGCTGTGC  550
  EBAC40  501  .......... .....C..GG .......... .......... ..........  550
  EBAC41  501  .......... .......... .......... .......... ..........  550
  EBAC64  501  ..AT...... .......... .......... .......... ...T.G..T.  550

EBAC31A8  551  AATCAGCTTA CAACACAATG ATGTATATTA TCATCTTTGG TTGGGCGATT  600
  EBAC40  551  .......... .......... ........A. .......... ......A...  600
  EBAC41  551  .......... .......... .......... .......... ..........  600
  EBAC64  551  .......... .......... ...GC...C. .AG....C.. ......A...  600
```

**Figure 9**

```
EBAC31A8   601   TATCCTGTAG GTTATTTCAC AGGTTACCTG ATGGGTGACG GTGGATCAGC   650
  EBAC40   601   .......... .......... .........A .......... ..........   650
  EBAC41   601   .......... .......... .......... .......... ..........   650
  EBAC64   601   ......A... .......... .........A .......... ..........   650

EBAC31A8   651   TCTTAACTTA AACCTTATCT ATAACCTTGC TGACTTTGTT AACAAGATTC   700
  EBAC40   651   .......... .......... ..G....... .......... ..........   700
  EBAC41   651   .......... .......... .......... ...T...... ..........   700
  EBAC64   651   .......... ........T. .......... .......... ..........   700

EBAC31A8   701   TATTTGGTTT AATTATATGG AATGTTgctg ttaaagaatc ttctaatgct   750
  EBAC40   701   .......... .......... .......... .......... ..........   750
  EBAC41   701   .......... .......... .......... .......... ..........   750
  EBAC64   701   .......... .......... .......... .......... ..........   750
```

**Figure 9**

```
EBAC31A8     1  MGKLLLILGS VIALPTFAAG GGDLDASDYT GVSFWLVTAA LLASTVFFFV   50
EBAC40_1     1  .......... .......... .......... .......... ..........   50
EBAC41_1     1  .......... .......... .......... ......A... ..........   50
EBAC64_1     1  .......... .......... .......... .......... ..........   50

EBAC31A8    51  ERDRVSAKWK TSLTVSGLVT GIAFWHYMYM RGVWIETGDS PTVFRYIDWL  100
EBAC40_1    51  .......... .......... .......... .......... ..........  100
EBAC41_1    51  .......... .......... .......... .......... ..........  100
EBAC64_1    51  .......... .......... .......... .......... ..........  100

EBAC31A8   101  LTVPLLICEF YLILAAATNV AGSLFKKLLV GSLVMLVFGY MGEAGIMAAW  150
EBAC40_1   101  .......... .......... .AG....... .......... .......N..  150
EBAC41_1   101  .......... .......... .......... .......... ..........  150
EBAC64_1   101  .......... .......... .......... .......... ..........  150

EBAC31A8   151  PAFIIGCLAW VYMIYELWAG EGKSACNTAS PAVQSAYNTM MYIIIFGWAI  200
EBAC40_1   151  G..V...... .......... ...A...... .......... ..........  200
EBAC41_1   151  .......... .......... .......... .......... ..........  200
EBAC64_1   151  .......... .......Y.. .......... .S........ .A..V.....  200

EBAC31A8   201  YPVGYFTGYL MGDGGSALNL NLIYNLADFV NKILFGLIIW NVAVKESSNA  250
EBAC40_1   201  .......... .......... ....D..... .......... ..........  250
EBAC41_1   201  .......... .......... .......... .......... ..........  250
EBAC64_1   201  ..I....... .......... .......... .......... ..........  250
```

**Figure 10**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag acc ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 11**

```
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 11**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 11**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt gct     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Ala
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 12**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 12**

```
tat aac ctt gcc gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 12**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 13**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg aag      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 13**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 13**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 14**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 14**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 14**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 15**

```
att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga ttg gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 15**

```
tat aac ctt gcc gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 15**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 16**

```
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 16**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 16**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 17**

```
att ctt gct gct gct act aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gag ctt tgg ctt gga gaa gga aaa gct gcg tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Leu Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat aca gca agt cct gct gtt cag tca gct tac aac aca atg atg atg      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Met
            180                 185                 190

atc atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gca ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 17**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 17**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 18**

```
att ctt gct gct gca act aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 18**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 18**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 19**

```
att ctt gct gct gct act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

caa att atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gln Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt ggg tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 19**

```
aac ctt gct gac ttt gtt aac aag att cta ctt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Leu Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 19**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 20**

```
att ctt gct gct gca gct aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Ala Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gcc tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ttg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 20**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 20**

```
atg ggt aaa tta tta ctg ata ata ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Ile Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 21**

```
att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tat atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat aca gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc gtc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 21**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 21**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 22**

```
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 22**

```
aac ctt gct gac ttt gtt aac aag aat cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Asn Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 22**

```
atg ggt aaa tta tta cgg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Arg Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 23**

```
att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc gtt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 23**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 23**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 24**

```
att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 24**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 24**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 25**

```
att ctt gct gct gct act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 25**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gct gct gtt aaa gaa tct tct aat gct                              750
Asn Ala Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 25**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

ata gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 26**

```
att ctt gcc gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

ctt gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctt atg ggt gac ggt gga tca gca ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 26**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 26**

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gcg tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 27**

```
att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga ata atg gcg gct tgg cct gca ttc atc gtt gga tgt tta gca tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Val Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tat atg att tat gaa cta tgg gct ggt gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gta cag tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc gtt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aat cta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

**Figure 27**

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 27**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg cta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 28**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att ctt ggt atg gct ggt tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Leu Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gct tac aat gca atg atg aag      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 28**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 28**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct gag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Glu Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 29**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 29**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 29**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gcc ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 30**

```
att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac cta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 30**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 30**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gcg ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt acg gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 31**

```
att ctt gcc gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca ttg gta atg tta ggt gct gga tct gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Ser Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctc ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 31**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 31**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 32**

```
att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac cta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 32**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 32**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 33**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 33**

```
tat aac ctt gct gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 33**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 34**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggc aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac cct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Pro Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 34**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 34**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 35**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg aag      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 35**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 35**

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat acc cca aca gta ttc aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110
```

**Figure 36**

```
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

cta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggc gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

**Figure 36**

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

**Figure 36**

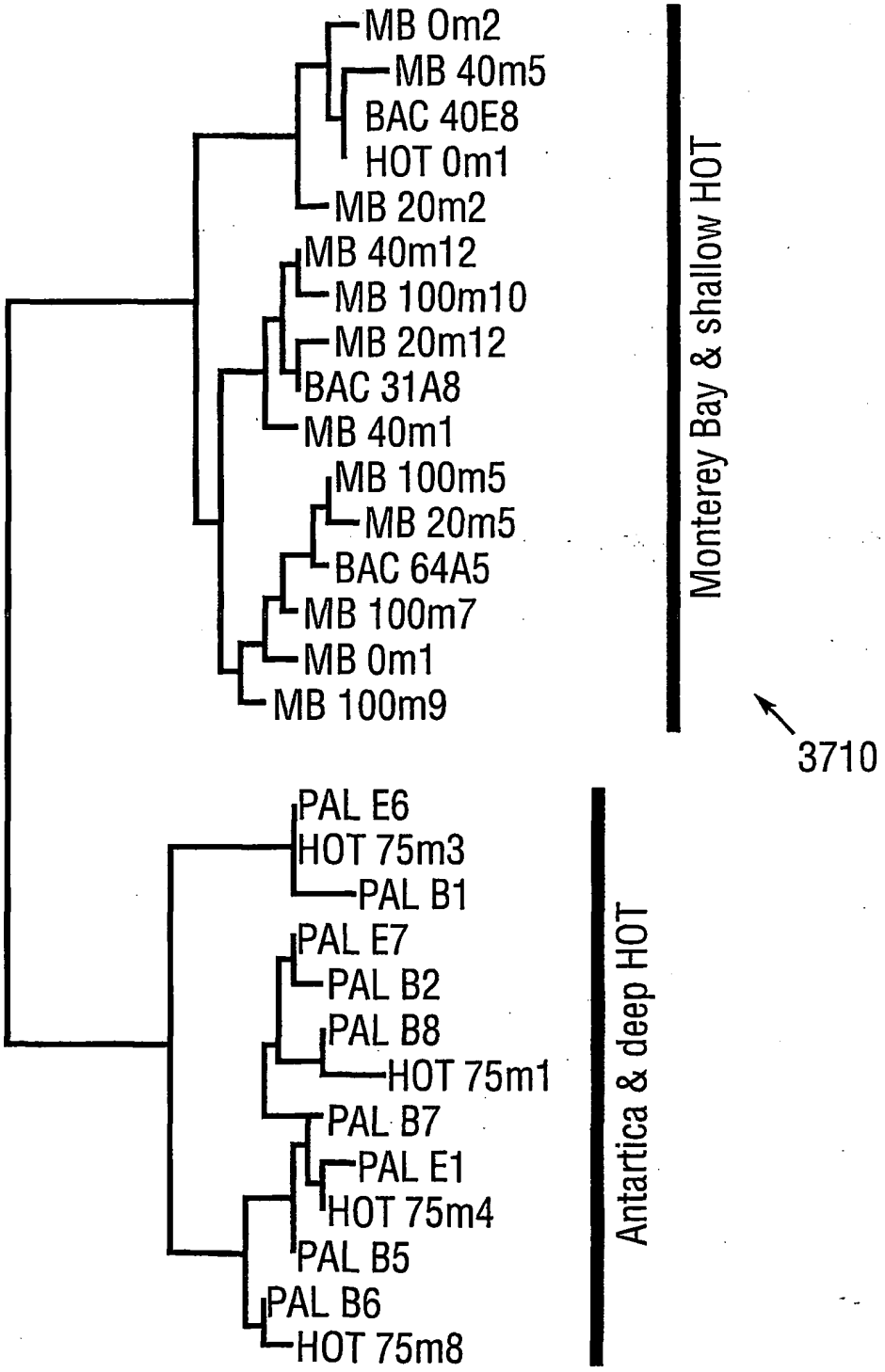

MB 0m2
MB 40m5
BAC 40E8
HOT 0m1
MB 20m2
MB 40m12
MB 100m10
MB 20m12
BAC 31A8
MB 40m1
MB 100m5
MB 20m5
BAC 64A5
MB 100m7
MB 0m1
MB 100m9
Monterey Bay & shallow HOT
3710
PAL E6
HOT 75m3
PAL B1
PAL E7
PAL B2
PAL B8
HOT 75m1
PAL B7
PAL E1
HOT 75m4
PAL B5
PAL B6
HOT 75m8
Antartica & deep HOT

**Fig. 37**

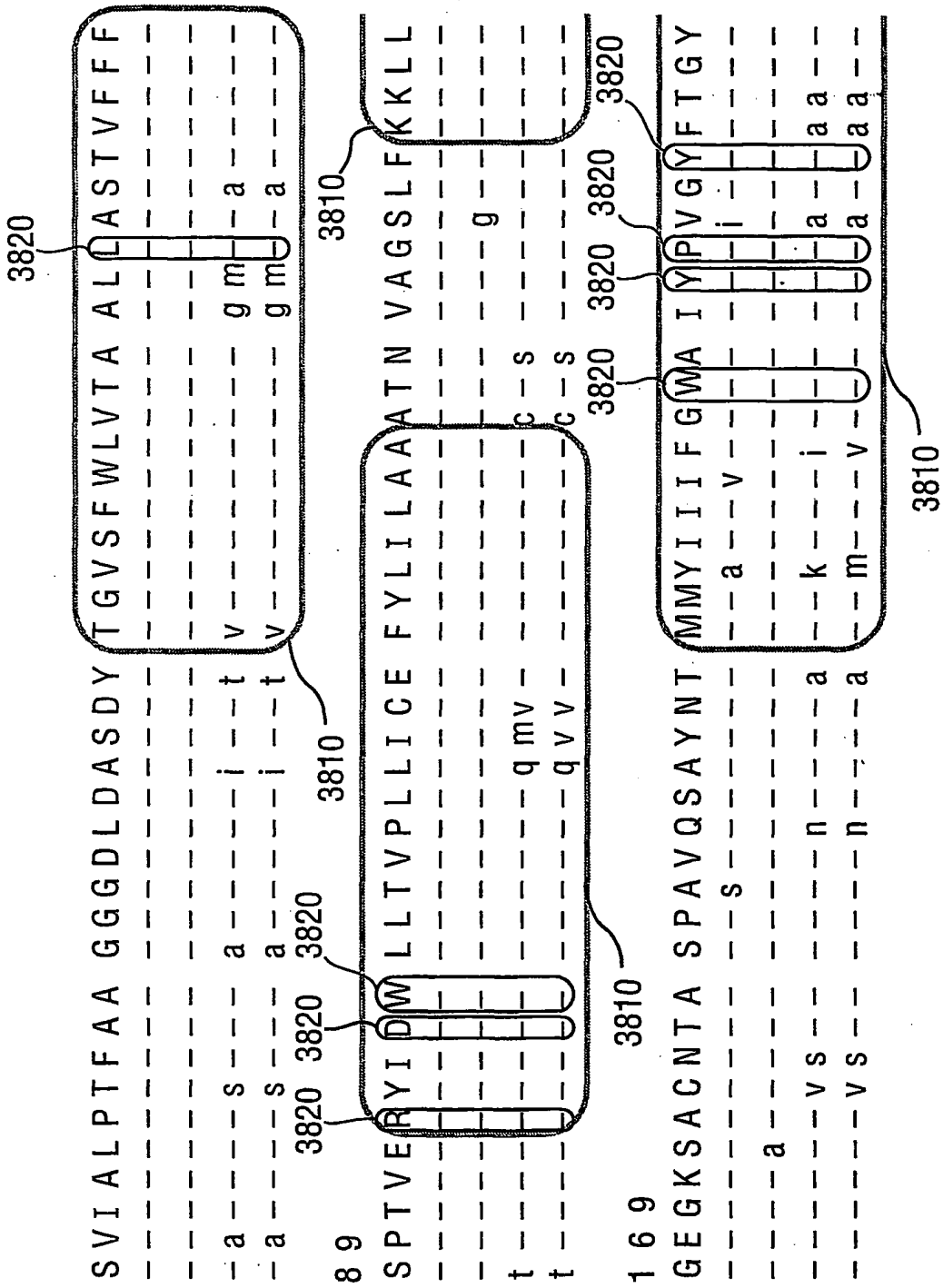

1
mklllilg
SVIALPTFAA GGGDLDASDY TGVSFWLVTA ALLASTVFFF
3820
3810
3820
3820
3820
3820
3820
3820
3820
3810
3810
3810
89
SPTVERYIDW LLTVPLLICE FYLILAATN VAGSLFKKLL
169
GEGKSACNTA SPAVQSAYNT MMYIIIFGMA IYPVGYFTGY

Fig. 38A

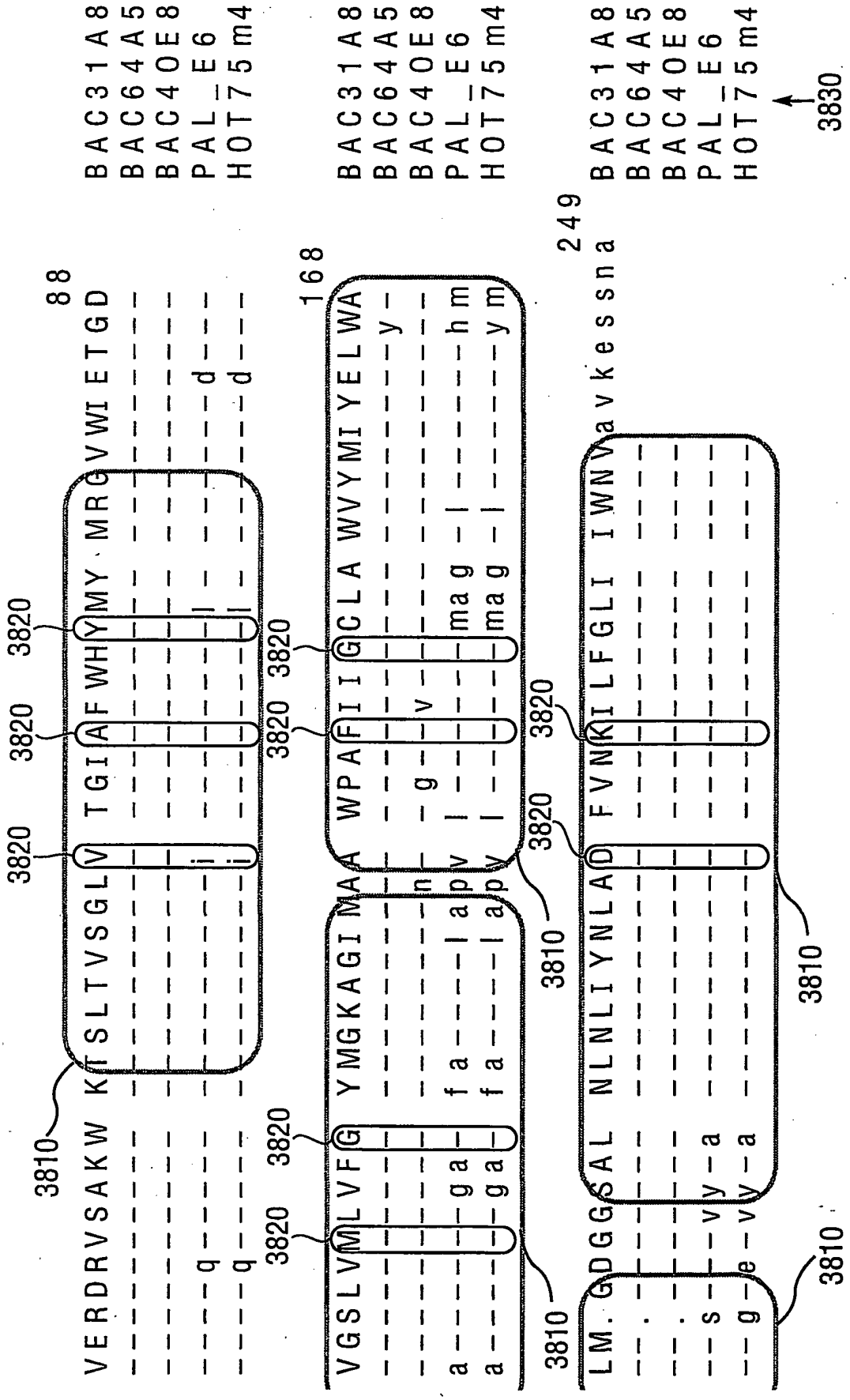

BAC31A8
BAC64A5
BAC40E8
PAL_E6
HOT75m4
88
168
249
3810
3820
3830

Fig. 38B

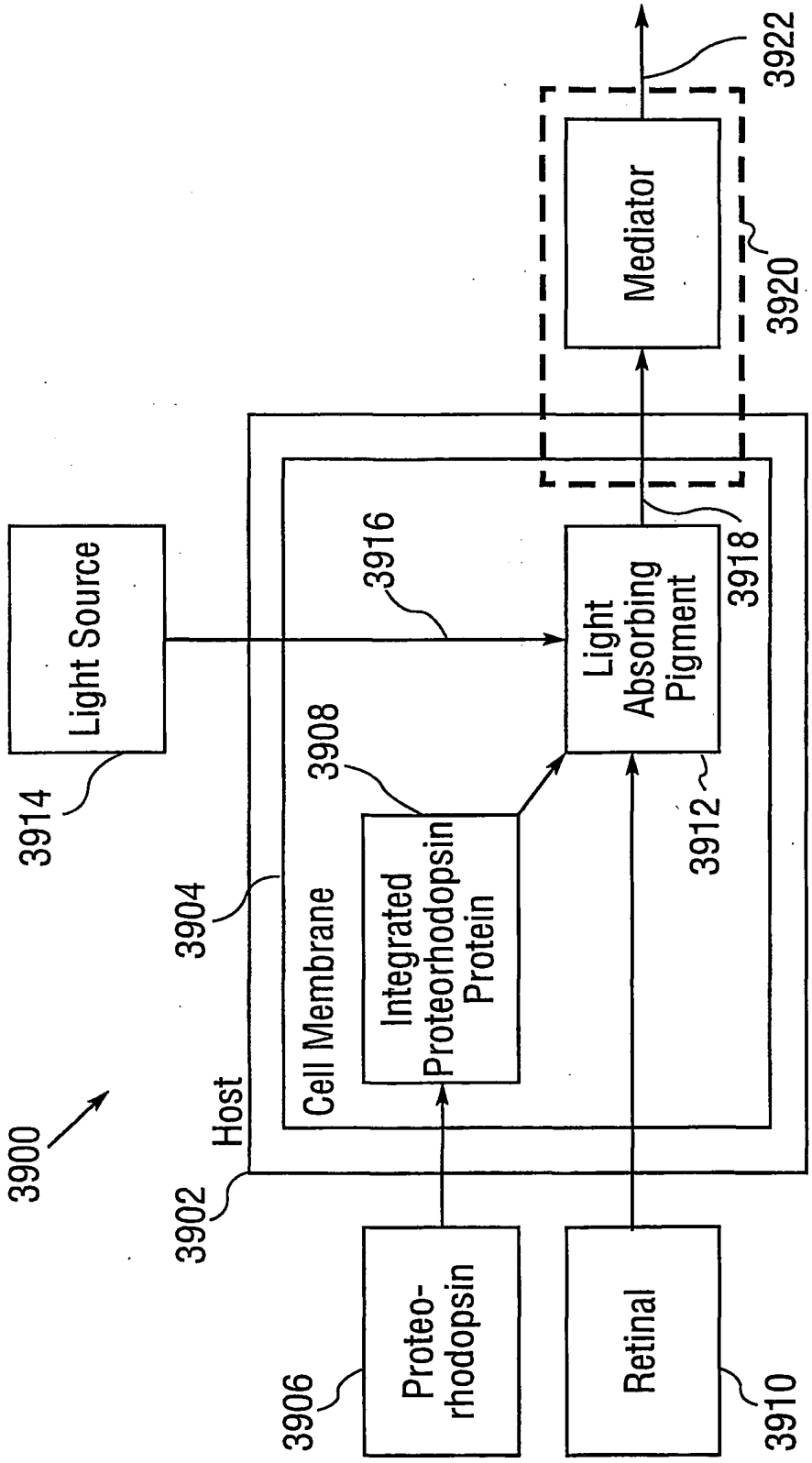
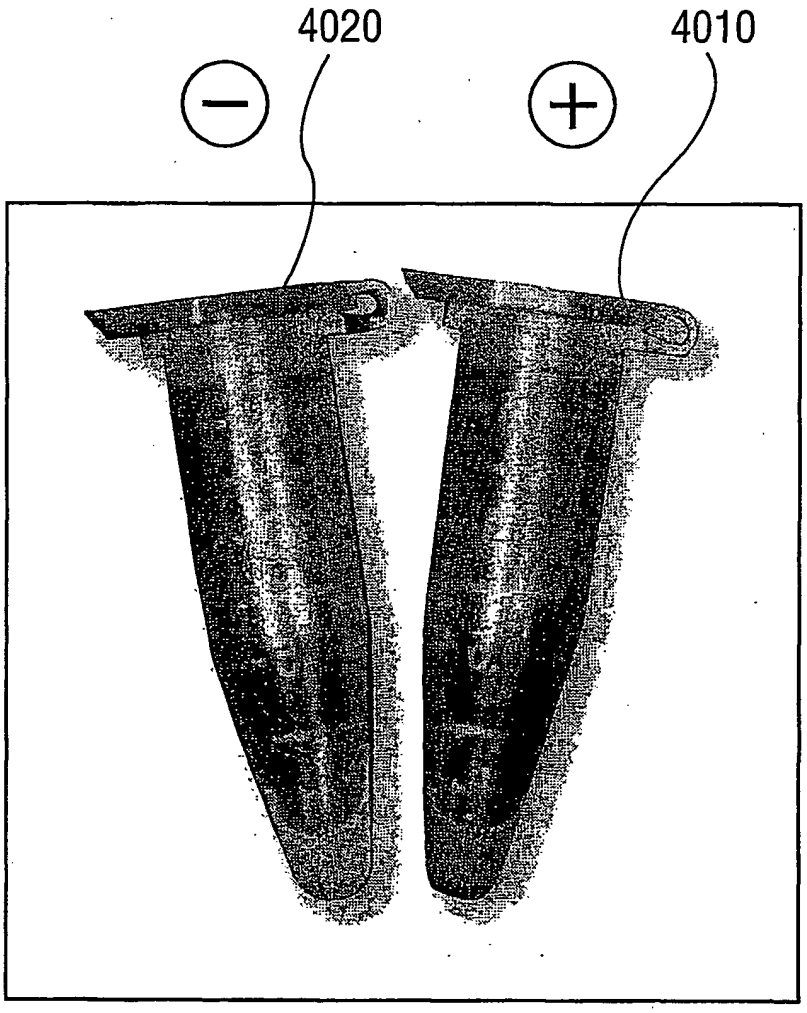

3900
Host
3902
Cell Membrane
3904
Integrated Proteorhodopsin Protein
3908
Light Source
3914
3916
Light Absorbing Pigment
3918
3912
Mediator
3920
3922
Proteo-rhodopsin
3906
Retinal
3910

Fig. 39




BEST AVAILABLE COPY

Fig. 40

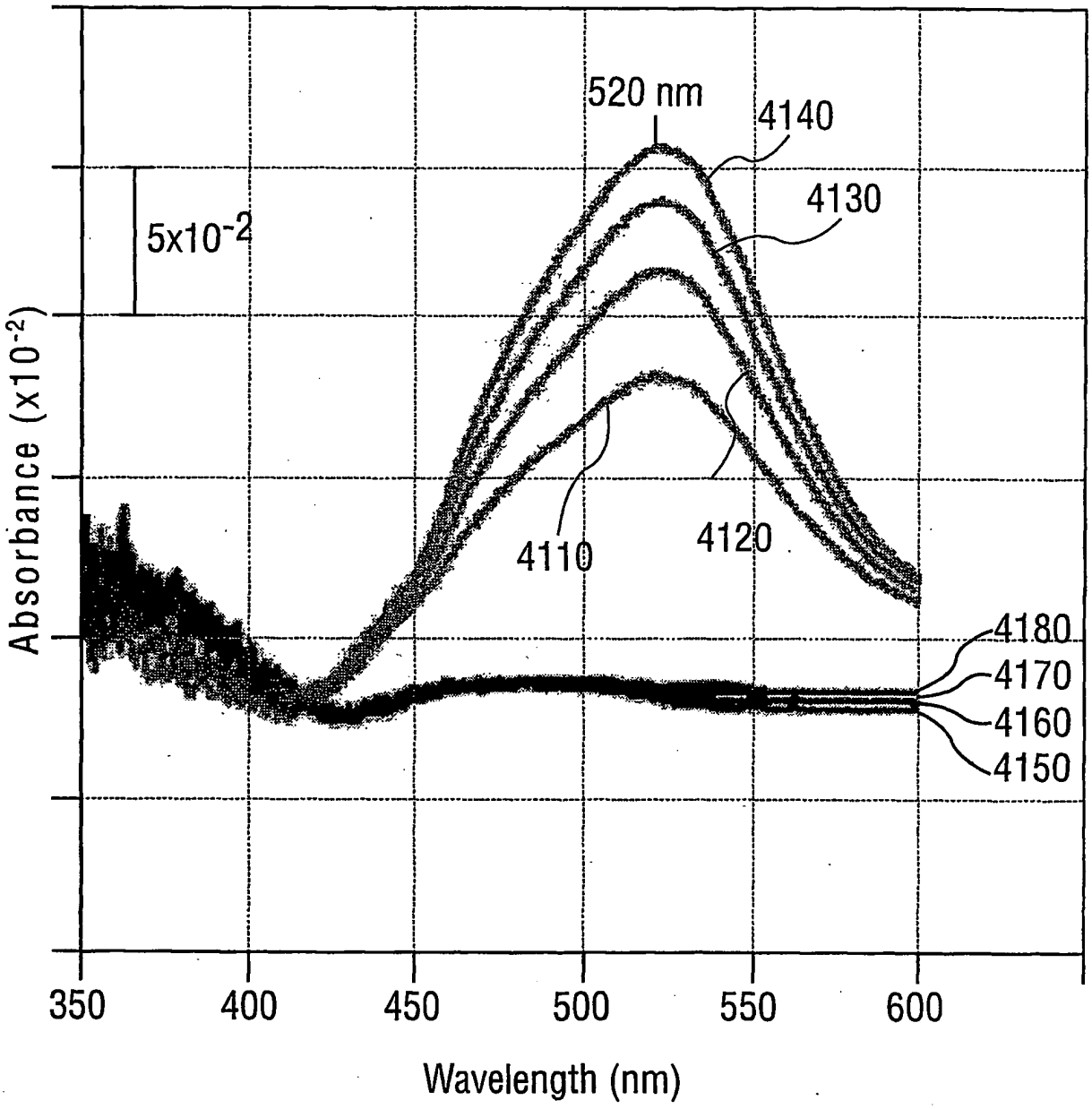



Fig. 41

BEST AVAILABLE COPY

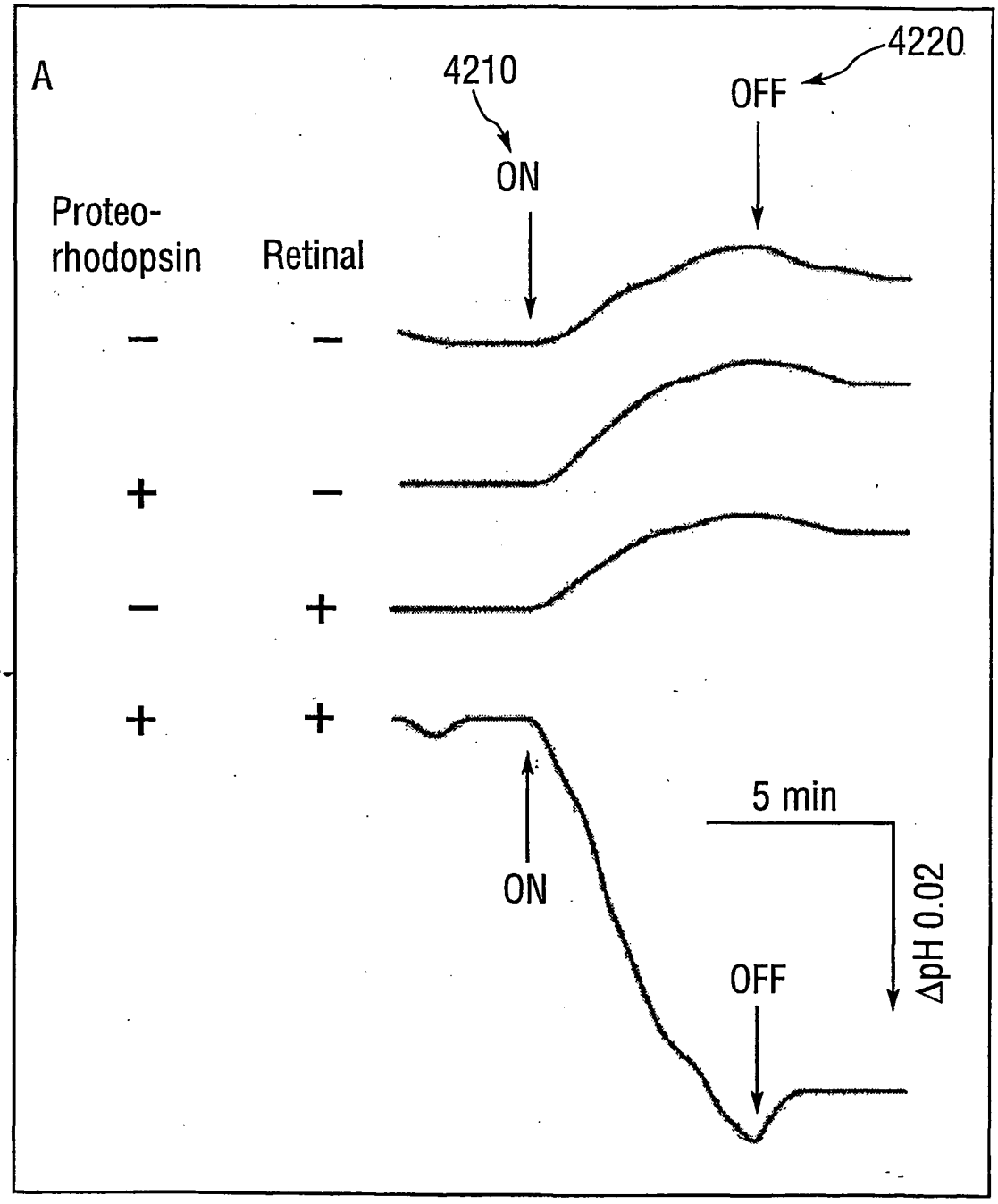

A
4210
ON
4220
OFF
Proteo-
rhodopsin
Retinal
−
−
+
−
−
+
+
+
ON
5 min
ΔpH 0.02
OFF

Fig. 42

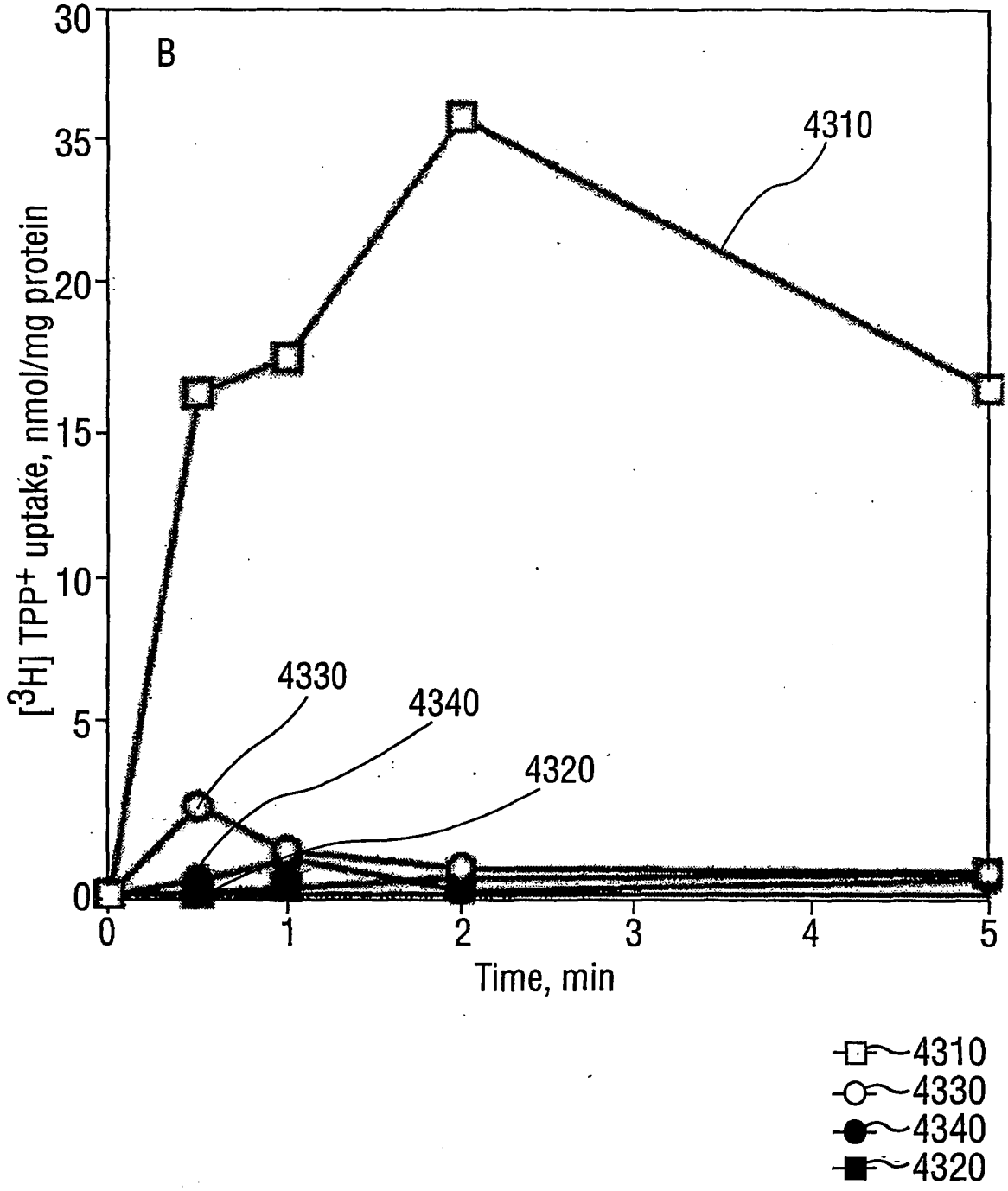
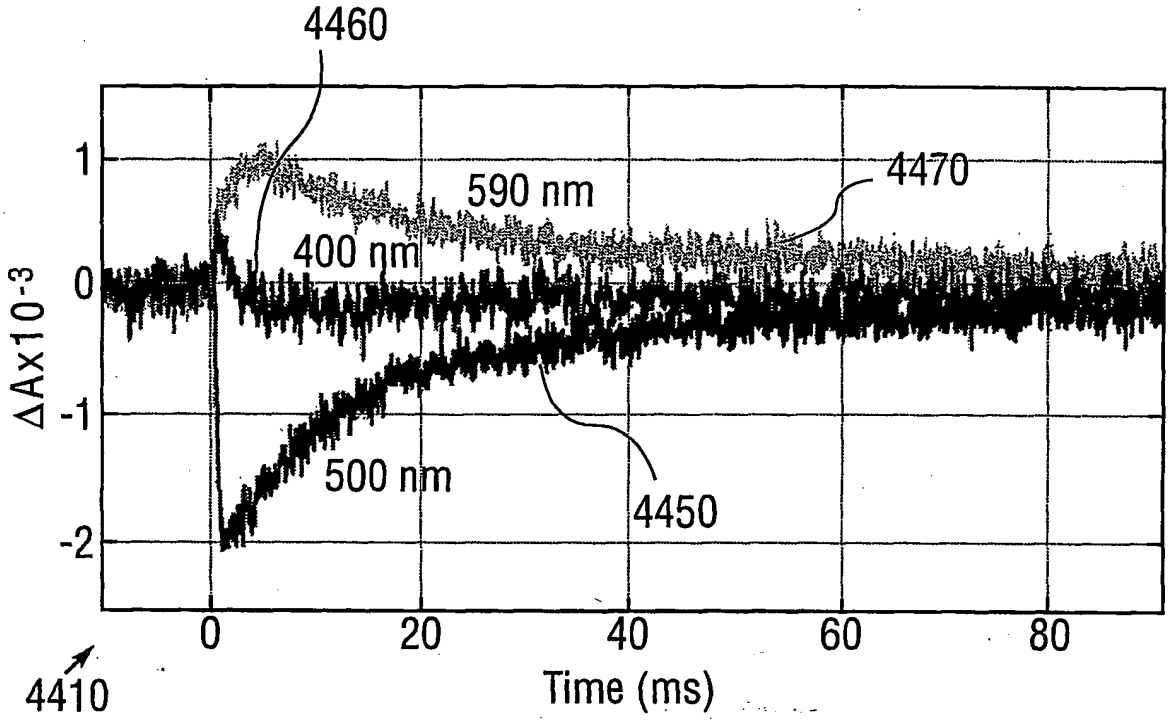



Fig. 43

BEST AVAILABLE COPY



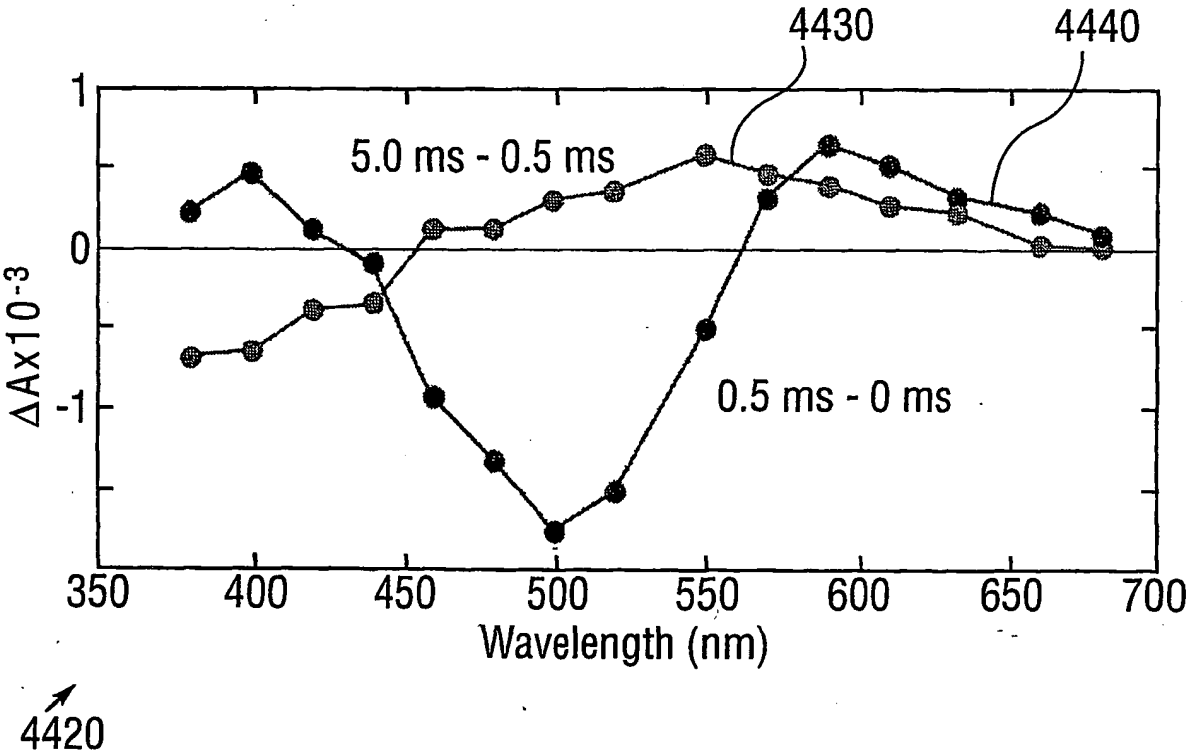




Fig. 44

BEST AVAILABLE COPY

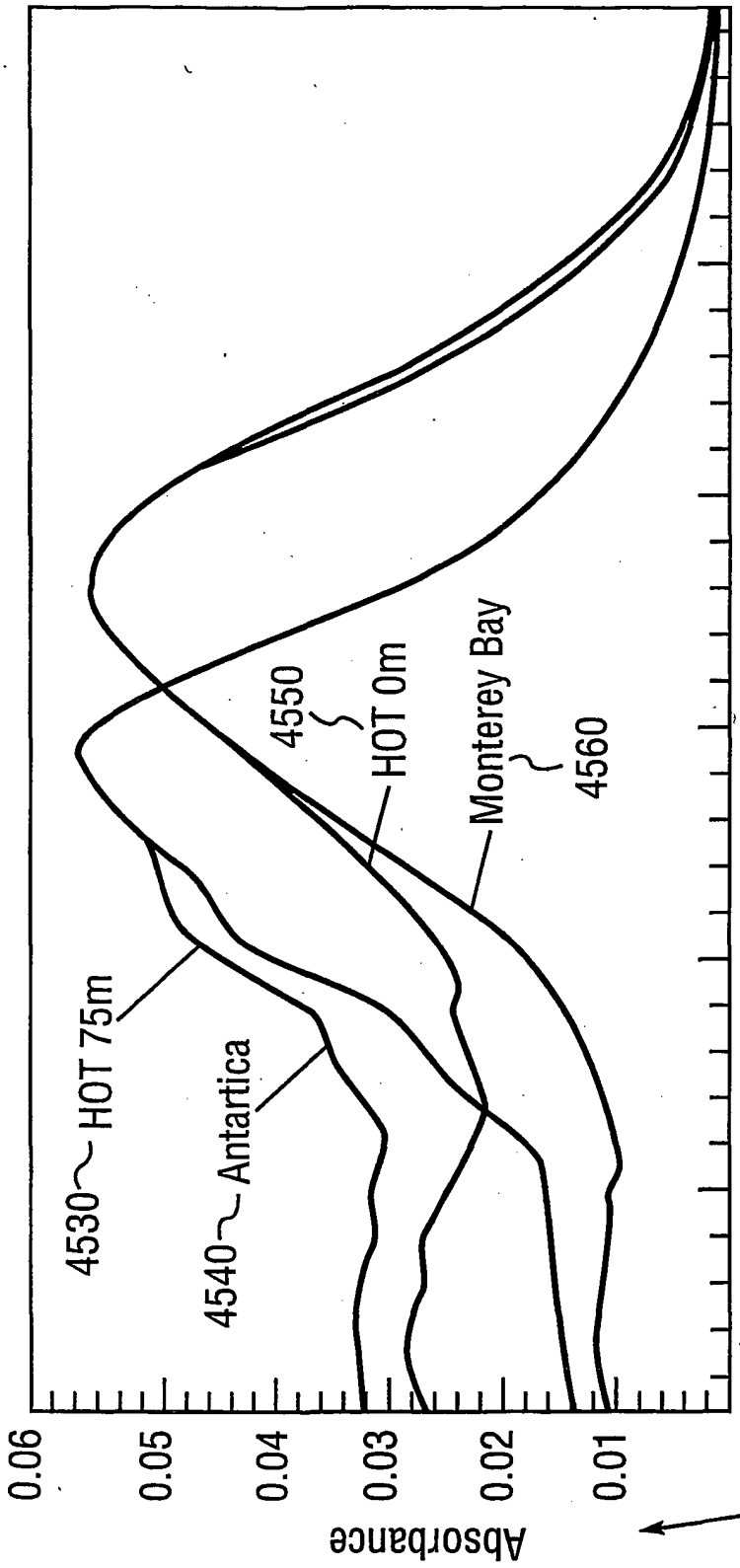

0.06
0.05
0.04
0.03
0.02
0.01
Absorbance
4520
Wavelength (nm)
4510
4530 HOT 75m
4540 Antartica
4550 HOT 0m
4560 Monterey Bay

Fig. 45

SEQUENCE LISTING

<110> MBARI
DeLong, Edward
Beja, Oded

<120> Light-driven energy generation using proteorhodopsin

<130> MBA-101

<150> 60/201,602
<151> 2000-05-03

<160> 65

<170> PatentIn version 3.0

<210> 1
<211> 105184
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS(complement)
<222> (50866)..(51615)
<223> light-driven proton pump; has the properties of a light-driven pr
oton pump when expressed with retinal in Escherichia col

<300>
<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T.,
Hadd,A.,Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A.,
DeLong,E.F
<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the
sea
<303> Science
<304> 289
<305> 5486
<306> 1902-1906
<307> 2000-09-15
<308> AF279106
<309> 2000-06-15
<313> (50866)..(51615)

<400> 1
ttgttatatc agtaatggct attgctccaa taacttaata ctaatatata attagtttat 60

gaataaattt tatatatttg ggttattgtt ttttacacta aatgcatttt cttgctcaga 120

tcttctagat acagacatga gagttcttga ttccgctgag tcaagaaacc tttgcgagtt 180

tgaaggaaaa gctttactag ttgtgaatgt tgcaagtaga tgtggttaca cttatcaata 240

tgctggcctt caaaagttat atgaaagtta taaagatgaa gattttctag taattgggat 300

cccatctaga gattttcttc aagaatactc tgatgaaagc gatgttgcag aattttgttc 360

tacagaatac ggtgttgaat ttcctatgtt ctcaactgct aaagtcaaag gaaaaaaagc 420

acacccattt tataaaaaac ttattgcaga atcaggtttt actccctcat ggaactttaa 480

taaatactta atctcaaaag agggcaaggt tgtatccaca tatggatcaa aggtaaagcc 540

tgattcaaaa gagcttatat cagctataga aggcttgctg taaaattatt acttagaaac 600

taatacagtt ttaggcttgt ttgctgcaaa tattccatta tctacaactc caggaatatt 660

attaatcaaa gcttccattt cagtggggtt tgaaatatcc atattagaga tatctaaaat 720

gtgattacct tggtctgtta taaatccagt tctatatgtg ggtattccac cgatcgagat 780

tatttttctt gcaacaaggc tcctactttc aggtatcacc tctataggca gtggaaaagc 840

tcccaaaaga ttaaccatct ttgactgatc aactatacat ataaactcgt tagaggcaga 900

agcaactatc ttttctctag tatgtgcgcc accaccacct ttaataagac aattttcagg 960

agacacctca tctgcaccat ctatgtaata agctatatca actacatcat taaggctaaa 1020

gacctctatc ccattttcat ttaataattt tgatgaagca tctgaactag aaacagctcc 1080

agcaaatttg tgcctatgct cctttagttc ttctataaaa aaattaactg ttgagccggt 1140

tccaatacct aaaatcatct caggatgaag attatttttg atatattcta tagcttgttt 1200

agcaacattt atctttgagc cactcataga gttataatac aagaaaatat aggtagttaa 1260

ttattttgag actaaaaatt aaaaaaacag gttcttttaa gaattcccag aagtacctaa 1320

agcttattcc taatgcatct gtttatgacg tagcattaaa atcacctata acatttgctc 1380

taaatatttc ttcaaagctg gggaataaag ttttcctaaa aagagaggat ctgcaaccta 1440

tattttcttt taaaaacaga ggagcgtata acaagattgt aaatttatcc gatgccgaaa 1500

agaagagggg ggttattgct gcatcagcag gaaatcatgc tcaaggggta gccagtgcat 1560

gtaagaaatt aaaaattaat tgcttgatag ttatgccaat aacaactcca gaaataaaaa 1620

taaaagatgt aaaaagattt ggagccaaaa tactccaaca tggggacaac gtagatgcag 1680

cattaaaaga ggcactgttt attgcaaaga aaaaaaaatt gtcttttgtt catccttttg 1740

acgaccctct aacaattgct ggccaaggga ctataggaca agaaattctt gaagataaaa 1800

ataattttga tgttgtcttt gttccggtgg gaggaggagg tattctagct ggtgtatctg 1860

cctggatagc acagaataat aagaaaataa aaattgttgg tgttgaggtt gaggattccg 1920

cttgtcttgc tgaggccgta aaagctaata aaagagttat tttaaaagaa gtgggcctct 1980

ttgctgatgg ggtggcagta tcaagggttg gaaaaaataa ttttgatgtt attaaagagt 2040

gcgtagatga agtcattaca gttagcgttg atgaggtctg caccgctgta aaagatatct 2100

ttgaagatac aagggttcta tcagaacctg ctggggcatt agcacttgca gggttaaaag 2160

cctacgcaag gaaagttaaa aataaaaaac ttattgctat aagttctggc gctaatgtaa 2220

atttccaaag acttaatttt attgttgagc gatcagagat tggtgaaaat agagaaaaaa 2280

tattaagtat caaaatccca gagatacctg gaagttttct taagctttca aggatgtttg 2340

gcagctctca agttacagag tttaactaca ggaaatctag cttaagcgat gcatatgttt 2400

tagttggtgt tagaactaaa actgaaaaat catttgaaat cttaaagtcc aaattaaaaa 2460

aagcaggctt caccttttagc gactttactc gaaatgaaat atccaatgat catctgaggc 2520

atatggttgg tggcagaaat agtgactcag gctctcataa caatgaaaga atatttaggg 2580

gagagtttcc tgagaagccg ggcgcgctgt taaattttct agagaaattt ggaaataaat 2640

ggmatatttc cttatttcat tacaggaacc taggttcagc ttttggaaag atattaattg 2700

gcatcgagag taaggataaa gacaagctaa taaatcattt aaataagtca ggnactattt 2760

ttacagaaga aacctctaac aaggcataca aagatttttt aaaatgaaag gttaatactt 2820

taatctaaat ttaattgaaa aaagctcatc gctagggttt tcccacggct ctttgaacaa 2880

ctcggattga gatctatcat cctcctcgtc gtaaattctc ccacctttag aatagaccaa 2940

aaatagatat gacaaaggag cgagctcata tttatatcta atttggaacg aagctacgcc 3000

agtattaaat tcattaacta tattatttcc tttataaagg tatccattag catctgaaaa 3060

aatactaata ggatttttg ctttcaaagc aacaaattga ctcttaagtc tgatctcatg 3120

tttattattt ttaaaccaat ttagatcaaa agataaggta tcttgtcttg aatcatatga 3180

ggcaagatta ttattatcct gccatatcag ccattcattt tcctttctta ttctatattg 3240

cgcattgatt cttaagttat catttggaaa tattgaacct gctatcttgt aaaattttct 3300

accataccca ttcgaatccc accgattatc tttctctccc ttaaagaagc taactctcca 3360

gtcatatgtc cagaatgaat agttctttgc ctcaaagtct gctgtaatac ctattcttct 3420

ttttgatttg ataaaggggt aggcttcatt ttttcttgtg atagttgtat ttttcccaga 3480

agatctaaag ttaaaatcta attgaaattt agagttgtcc ttaaaactaa aagaattttt 3540

ttgatcgatg cctattggat ttgaattacc agctgtgtca gcatcataat ttagatcaat 3600

tccataatct atttgtttta atatcgagct attatcaaat tcatttattt ttcgatttcc 3660

tccaatacca gcatgaatcc agtctcttct ttgcagataa ccaaagtcat ttaactcgaa 3720

gtcgtcttca aaataaagaa ggcttccact tatgttagat agtttatttg gaagatatgt 3780

aaactgagtc ctatacccaa gcccattttt accatctttt tctgaggcta acagatctga 3840

atatgtaatt aatttttttg aacgaatatt gatgtaatca ataacattga ctgttgatga 3900

ttcgcctgtc atttcattct caacattcgt taccatgaag ccaagcgttt tatttccaag 3960

ctttgttcga gatcgaagag cataatagtc tcttccaact gaaaaggctt catcagcctc 4020

acttgctaca aatactccaa attcattatt attacttttt tgagtaagtc ttaatgcaaa 4080

atcaatatca gaatagtttt ttttagctgc ctcgcaacct tcttcattac tttcttctga 4140

gcaattatag ctgggggcag ctccaatcct ccgcgtattt ataaccgagt atctatcata 4200

attactaata tcaaatagtg attggttttc attgaaaaat gctctttttt ctgagtaaaa 4260

agtttcttga gcagaaaagt taataaccac atcatcactc tcagcttgtc cgaaatctgg 4320

attaatagct aaatttattt gacgaccttt tccagtgcta taaaagattt cagccccaat 4380

atctgaccct tcttggtttg taactgaatt tttatttgaa gatatatatg gaaaaaaagt 4440

aagctttgat tttgtatagt tttgtatttc taagctatct aactcttgaa agtagtcatt 4500

tctactagcc attgttccgg cactgctaac ccatgactca ttttcggcac tataacgtaa 4560

tgcggtgtaa ttaatttttc ttatatcacc atcaggctgt ttcattaacg ttacatccca 4620

aggaataaaa aactcagaga cccaataccc atcaaatttt tgtgtttttg caatccaatc 4680

tccatcccag tctgtcttaa agtctcctgc ttgcgttttt atggcatcga aaagcgagtt 4740

cccaagattt atagcaagaa tgaaagcttt gttaccatca ccatcaaagt ctatatttat 4800

agagttttta tcgctaagtg aatttatttg atctctaagc gtcttcctgg agaacataga 4860

atcattactt tgaaaattct taaatccaac atatatacca tccttatttg agaaaattaa 4920

agccgttgta agaagttcat ttttcttaag agtaaaagga gatgtttcat aaaaatctgt 4980

aatttcaaat gcattattcc actcaggctc atcaagagag ccatcaataa caattgagtt 5040

tgaccaaatc agcacagagg taagtaaaag tgataatgag gctaaagtta ttttcataga 5100

tagatttaat tcagagtatt ttaatctatg aagagtagga aatcatccga tcattctcag 5160

aaaaaacata atcatattta aggtcatgtt tttctccaaa atgcatatta caaatctggt 5220

attgataaca cagtccaacc aataaaggtc ttgatacctc ctcgtttata gagccaataa 5280

ttctatcgaa atatccagag ccatagccaa gcctgtatcc atttaaatca actcctgtca 5340

taggaataaa cattaaatca atttcattta tgttgacata atcttcactt ttaacctctt 5400

tgatcccaaa ttgatttata aagaagttag gctgctcatc cagcaaatta aaagccatca 5460

tttcgtcatc aattactttt ggaatataaa tattcttttt aagtttagta aaagcttgaa 5520

ttaacaaatt tgtattgact tcatttcgaa aaggaaaata taaggcaatg ttttgcattt 5580

catgagtatt gatttttttct aatacatttt cttggattaa aaaacttata ttgctcttag 5640

ataaatcaga aatagactgc ccctgctcaa agagtgattt tcgtatttta tttttcacca 5700

taaattgtgc cgaggctaac aaaccaaatc accgccatgt gctatacctg aaccgatggg 5760

tcaggtggtg aatttcataa caaatcaggc ttccctgtaa aggtactgcg caacaatgct 5820

agaggaatat cacctattta attgtatcgg ttcaaattta ttaacacatt agcgtatgaa 5880

ccagaatgca gttaattata aaatatatag gtattaagta aaagttaatt tttagagagc 5940

agactctatt ttttgtatta gcttttcgat atctttatta tttaaagcag agtcagtatt 6000

ctcggttggc ttggataaaa gcttactagc catagttaga ccagctatca ccaaggcatt 6060

attcttatca ctgatgccat caagctcatc atttaataat tttgcagctc taatgagttg 6120

gtctttctct tctggcggac aggctaacgt cagatctcgg ccaaaaattc ttaaagatag 6180

cgtttccatt tctgacatta ttttttgagt ttagttattt ctttatttag tatgagctta 6240

tctttttcc agtctctttc cctttgcaca taagaatcta ttattccttt ttgctcatca 6300

aatcttttta tcaaaagatc taccttatcc tctagttcaa ataatgatga ttttttttct 6360

tctgacattg tataagttta attgtactag aatgaattgg aaagtttctt taataaaaga 6420

gtaaaataag gcatggaaaa aataattttt aaaaacagaa gagattcact tataaaacac 6480

ctacctaaga attcagcctt aattgtacct ggtgcagatt tgcaatatag aaatgctgac 6540

tcatcttata atttaagaca ggaaagtagc ttctactatc tgtctggctt ttgtgagccc 6600

tcttctctaa tggttttagt taataatgga aaaagcattg attcaataat ttttgttcct 6660

gaaaaagata aacttaaaga aatctgggat ggttatcgag ctggccctga gggcgcaata 6720

aatgattttc tttttgatca agcttttgaa aataataaat cagatgcttt aatgcctgaa 6780

atccttcaag ggctagaaaa agtttttttat tcaataggga agaaaaatgg ctttgatcag 6840

aaagtaattg actggacatg cgcagcaaat tctaaagata ggcacagcaa atcaattgat 6900

attattgatg gctcttcgat ggtaggaaat ttaaggctta tcaaagataa gcatgaaatt 6960

gatattatga agagagcttg tgaaatttca gctgaatcat atattgaggt catgaaatct 7020

ataaagcctg gggacaatga gcaggaaata gaggcgctat ttttatatga attcgccaaa 7080

aggggaggaa ggtttccagc ttatacacct atagttgctg gaggtgaggg tgcttgtgta 7140

ttgcattata ttgaaaatga taaagagtta gcttcatcag atttaatttt ggtagacgca 7200

ggatgtgaat acaaaatgta tgcatctgat atcacaagaa ccttcccagt aagtggaaaa 7260

ttttcagatg aacagctaca aatttataat attgtccaca aagccaatct tgctgcaatc 7320

gatgctgtaa aaactggtaa tagcataatg gagccccaaa tggtttcaga aaaagtaatt 7380

actgaaggtc ttgtagagtt gggtattcta tctggcgatg ttaatcagct tcataaaaat 7440

ggtgcattca aggactttta tatgcataag gtgggacatt ggcttggact tgatgttcat 7500

gatgttggtg actacatgga gggagatgag tttatgaagt ttaagccagg gatgataacc 7560

acaatcgagc caggcatcta tatcagtagc gcaatggatg tagatgacaa atggaaaggc 7620

atcggcataa gaatagagga cgacatcctt gtaacagatt caggcaatat taatctaaca 7680

gagaaggtgc catctaatcc tcaagaaata gaatcattga tggcttagac tatggaggtt 7740

ccaattgtta tttctggcgg agggataata ggtaattaca tttctcttag gcttgaaaaa 7800

aataatatca aaaccgttat tgtcgaaaaa gctagtagtt tcaaagccct agataagggt 7860

ataagaacag tcactctcaa tgagcattct atgcaaatgc taaaaaatat tggtatttgc 7920

ccatcaattg ctcaaatcaa cagcatcgac gtattagatg gtgagggtac aggcaaaatt 7980

caatttctag caaaggacgt aggcagcgaa aacctttcat atgtaaccta tttcaatgaa 8040

ttacaaaaac taatttctga tccatgtaaa gaaagaacct tatttaataa tgagattgat 8100
tcagttcaga atcttaatac agaatctgat ccagagatca tgcttaaaga tggcatgacc 8160
ataaaaacga atctaattgc tggatgtgat ggaagaaatt caaatattgc aaaaattgct 8220
tcacttacaa gcagcttcga tgactactta caaacagctt taacttttgt cgttgatatt 8280
gataatgatt cacatggcaa agctcaccaa gtttttttctg aaaaaggaat atttgcactt 8340
atgccactcc cagaaggcaa gggtgagatg aataaatgca cagtggtttg gtcaataaaa 8400
aatcaagttt tgggagatga gcctgtatct gagtttgtaa aaaataacat ttctttttt 8460
gaatcaaagc ttaatgttag tctcagggtt aagtcagaaa ttttaagttt taaattatcg 8520
aaccatcatt ttgaaaacta tattagcgga cctattgttc ttcttggtga tgctgctcac 8580
tcaattcacc ccttagcagg tcaaggtatt aatctaggat ttgcagatgc agatactttt 8640
tgtgaagagg taattagttc ttataaaaaa gggattgcct ttaatgagaa atcagtttta 8700
aaaagatatg agattagaag aaaaagtatg aacttttaa tgttgaagtc tatggacttt 8760
tttgtggatt tatttggttc agaaaattta tatctaaggc tgatcagaaa tttaggtatt 8820
tcttcgttaa ataaatcaaa gtttgttaaa gcattcttta taagacatgc ctctggaatg 8880
aataagtttt aaatttgtat taaacttttt gacctttagc tctaagttct ttaagaactt 8940
cactaatgcc ttttttatca atgattctca taccttttgc agatacttta agatttacga 9000
acctgttctc agattcaacc caaaatttgt gtgtgtgaag attaggaaaa aactttcttt 9060
tagtcctatt tttagcgtga gaaacattgt ttcctgactg tggtatctta cctgttactt 9120
gacatatttt actcattgaa acgcgatttt atagaacact gaggaactta gcaatactat 9180
tgtgaaacaa atttatttat tacggcatgc acaatctgac tgggagagct ctaatcagaa 9240
agattttgat agaccattag caagaaaagg cattgaagaa gcaaataaaa tatcatgtta 9300
ctgcaaatct cattcaattt tagtagataa aatattctgt agcactgcag aaagaactaa 9360
gcagactttt gatatatgca gtgatgggct taattatcca atagctgaag cagtctatac 9420
tgatgagctt tacttttctg gccctggtga gatcgttaag cttatccaaa gtttaagtga 9480
attcatttcc tctgttttaa taataggcca caatccatca atgcaaatgt acatagatgc 9540
tatttcagaa aatcctcata ttacgtattc aacatgcggg ctggcagaaa ttctcgttga 9600

aagttcatgg aaagacttat ctttaaaaaa atgtaagtta aaatctttta ttcaaccagg 9660

agagctttaa aaattgaaaa acataaaaat taagatcatt aacccactaa tgggatccaa 9720

gataccctta cctcaatatg aaacaaaggg ctcggcagga ttggatttaa gggcatgcct 9780

agatagtaat ctcagccttc aagcaggaac atctcagttg atacctattg gttttgcaat 9840

gtacttagaa gatcccggtc ttgcagcaat ggttatacct agatcaggtt taggttctaa 9900

gcatggaatc gttcttggta atctggttgg gttgattgat tcagactatc aaggagagct 9960

aatggttcct gcctggaata gatcagatac agattttgag attaatcctg gagacaggat 10020

tgcacaaatg attatagttc cagtgattca agcagatttt gaaattgtag acgagttcaa 10080

tgagactcag aggggagaaa agggttttgg aagttcaggt ataaattgat aaatttactt 10140

tttcttgcca aatctttctt caaatttctg aactcttccg ccagtatcaa taatttttg 10200

cttaccggta taaaaaggat gagaagcaga ggatatatca agagggtagt atgggtatgt 10260

ttttccatct tcccattctt tcgtttgagt cgtatctaat gttgaacgaa tgagaaagaa 10320

cttatcagca ctagcgtcat ggaataaaac ttcacggtat tcaggatgta tatcttttt 10380

cataataaaa tcaaaatttg gatgagaact ataacaaaaa acaacttctt ttcaatcaaa 10440

acatgaaaat tttttactat gacatagctg tttcattgcc tctaaggcaa tgctttactt 10500

atagttctga gcttaaaatt acaaaaggaa cccgcgtgtc agttcctttt ggtaaaagga 10560

agattgtagg agtggttata aaaaatattc aaaagccaga tttcctaaaa aaagcgggag 10620

ctataaaaaa aattatcgct gtacttgatg aatatccttt gttcgacaag ccaatttttg 10680

attctatatt gtggtcttct gattactatc atcatcctat tggtgaggtt tttaatacct 10740

ttatacccac cgaattaaga aaaattaata ataaaaaaat tgaagcttta agagaatttt 10800

ctgaatattc agtaaatgag gatgataaga aattcgattt aaccaaggat caagaaaaag 10860

cagtcaaggc gctttctaaa tctaaaggat tttcacccac tttattatat ggagttacag 10920

ggtctggaaa aacagaagtt tacttaagag ttgccgaaac ttttattaaa aataataagt 10980

cagtattagt tttagttcca gaaataaatt taacccccca attgctctcg cgatttgaga 11040

atagatttaa tggtgaaatt ggcatatatc attctaagca aacagcagct aagagattaa 11100

agacttggct aaaagctaaa tttggttcta taaaaataat agtaggaact cgatcttcgg 11160

ctttagtgcc tttagataac attggtttaa taattatcga tgaagagcat gaccaatcat 11220
ttaggcagtc agaagggttt aaattctctg ctagagactt aagtataaaa agggcacagc 11280
ttgcagatat tccaattatt ttgggatcag caacccccttc gctgcaaact ttaaaacttg 11340
taaaagaaaa taaatttata agagttgata ttcctaatcg agttgatgga aacaagcctc 11400
ctaaattaat agccttagat atcaataaca gccctttaat aggcggagtt gctaaagaga 11460
caattgaagc aatgcaatca accatagaca gaggagaaca ggttctagtt tttattaata 11520
gacgaggatt cgctccactc tatcaatgta gtagttgtgg gtgggtagca gattgtaaat 11580
cttgtgatac aaatttagtc ttccaccagg caagaaatag attaatttgt cataggtgtg 11640
aatctgccta ctctgttaat ttgtcttgtc cggcatgcaa gtctaatgac tttaatatgt 11700
atggagctgg aacagagaga gttgaagaag ttcttaaaag cagctttgta aagactccaa 11760
taattagagt tgatcatgac tcaacaaaaa aagtgggagc tatggaggct atagttaaaa 11820
aaattcattc ctcagacgca gcaattttag ttggaactca aatgcttgca aaaggacatg 11880
attttcctaa agtcaccttа agcgttattt taaatgctga taatggcctt ataagcccag 11940
aaattaatgc attagagaaa atatctcaat tgcttattca ggtctctgga agagcaggaa 12000
gaaataataa tcttgcaaaa gttattattc aaacaagata tcctgatgat ataaatctta 12060
ataaaattaa gacaggagat tatatgaaat ttgcttctca atgcctaagt accaatgagc 12120
aaatgaactt acctccattt actactttat gtctgcttag gtgctcatca ccaactcaaa 12180
agagtaatgt agatttccta gagaaagctg ttttaatttt atccaatagg actgatataa 12240
atgttattgg tcccttgcct tcattagttt cgaagtcgaa aggaaattat aggcaccaag 12300
tctatatcca tgcaccaaag aagacttttt taaataaggt attaaagttt ttgacaacag 12360
agtttgaaaa atggccggaa tctaataagg ttaagtggtc tttcgacatt gatccaatag 12420
acttaagcta aatattaatc ttaattaatt gtcctgggta tattggttta ttgtttagtt 12480
tattctctgt attaatttct tctacagtca ccccaaatct tatcgctatt tctgataaga 12540
catccccttt ttgtattttg taagtcacaa agcctggatc aatactcata aaggtatttg 12600
ctttaggttt gtccttaaaa tagttatgta ttcctaggaa aacagatctt gcaatcattc 12660
ttctccctgg cttgcccttt aatctttgtg cgtcttcagg gttggttata aaccctgact 12720

caaccaatac agaaggtata tcaatagact taagaactct gaaatcagcg tactcaacat 12780
tctttttatg aatttttgtg aaagggtctc ttttaagttg atccaatatc ttagttccta 12840
aaattttact ttcagaaatt tttttcttat atatttctgg ataggtttgt cttgccgcat 12900
cctcatcaaa atcaactggc tttagatttt ttatatcagc ctgtattctt tccctttgtt 12960
ttttagataa gttcctagca acagtacttg aagcttcatc tgaccatata aaaacagaag 13020
caccctttac ggaagataat ctaaacccat cagcatggat tgaaacaaaa atatctgctc 13080
catatttcct agcatcctgg tatctattat ttaaatctaa tgtctcatct ccatctctaa 13140
tcatcaccgg tctgtaccca taagtatctc ttaaggttct ttctaactcc ttcgcaataa 13200
gtaacgtcac atctttttct aaaatattat ttgggccaac cgcaccaggg tatttaccac 13260
cgtgacccgc atctatagca acaacaatat ctctaatact tttattgagg tttttatttc 13320
ttttcacctt aagctctaat tttatatttt ctgtatttat agtctgagtt gggttttgcc 13380
aatggactga ttcatataaa tcaacaacga ttctggtaag acttccatcc tgagatgctc 13440
ttacttttt gattggatag ttgtatggaa catttatctc ggtcggaagg ctcgattgat 13500
taatttccat gacaattcta gagggatttt taaagaataa gaccttacca atgaaacttt 13560
atctagacta aagttaatac taatttcatt gttacccatg tcttgtattt catcgaagaa 13620
aacatcattt ccgctgataa aaaaagatag aaaaccaagg attgccaatc tattcataag 13680
tttttaacca ttctttaaag ccattgtcac cagaaattaa agaaacctct cttccttcag 13740
gaagatggct gaaaattatt tttagatcaa aacttctttc atgttgaagc ctttcaggcc 13800
actcaattag cactactttc ttagagttta tttttctact tagatcaaat atatcaatat 13860
cttctgcttc gttagttcta taaagatcaa tatgcaaaaa cattaaatta ttaaaatcat 13920
attcctcgca gagagtgtaa gttggacttt ttacaagatc cttccatcca caatttttta 13980
taatagatct agatataaag gttttgcctg ctcctaagtc tccctcaaga tgtatttcaa 14040
tttcttgcga agaagattta agtatctcca tagctatttt tgaccctagt tggtttgtag 14100
cctcgtcatt tataagagta agtttttca tcgatttatt aattgtctta ttataggtat 14160
taaactagag gcatttaagc ctatttcacc aatatctacc ttaaatttta aacctgcctc 14220
cgaatgaaca gcaacagcaa taatgctcgc atttcttata tcaagacctt gggcaagaag 14280

agcagtcaaa acaccagcca gaacgtcacc agttcctcct gaagcaagtt caggtccgcc 14340

gcacgcgcat ataaaagact tgttatttgt tgagtcaaag accaccgttc ccattccttt 14400

taatatgaca atagaagccc cataagtgtc tgcaatttgc ttggcagcag aaatcctatc 14460

tctttgaact tcttcaatag atatgtttag taatatagcg gcctctcctg gatggggcgt 14520

catcaagatt gttttattgg atttttttgat taaagatttt gatgatgcca cgatgtgtaa 14580

agcacctgca tctaatataa tttttgaatt atttgcagac tttaatattt tacccaatat 14640

agtttttgca aaagcagtat tagcaattcc tggtccatac aatataacgc tatgatcttt 14700

aatttttaaa tctatatcga ccccttcaac catatcaaca ccaattgcca ttacctcagg 14760

gtttcttaat aaagatgggc ttacattaga cgtgtctgtg acgagagtta ctagtccaga 14820

gccacaaaat aaacttgcct cagatgcaag tattccggcg ccacccatgc ctggggagcc 14880

agcgcatatc aaaacttttc caaaattacc tttatggcta tcctttgctc tattgggcag 14940

aagatttttt aattcttgaa aggtaaaact ttgcaatata gacatgaaat tacttaagct 15000

aaattatgtt gaatgctaaa aattcattct tcagcgaaat aaccaatcct atcggaatgg 15060

aatgatccca taaaaatttt ttcgtcatga ggcactgcaa tagtgggtag gccaaaaact 15120

gttctagaaa atgaaaactt atcttctctc ttaagtgttt tttgattaag tttatgaatg 15180

gagaagggta gagaacaatt tgtttttttct gcacaattac caaaatcatt agcctgtaaa 15240

tctaaagaag ttaaccaaac cgaaccgtct tttaaaaaga tattatctgg actctgaata 15300

aaataactac ctgttttagt attttgatta atatcgtaaa cagataaatt gtcaccttga 15360

ttatagttaa cataaagaag tccagagccc tcatctagca aaattccatt aggcccactt 15420

ccatctgttc catcaacttt attaaaatta ttgtcactcc aaagtactac atgccctgaa 15480

atacttttaa ataatgaatt cattaaccat tctttcatgc tgatatctct tttatacata 15540

tgagatgcat aaaaacttcc atctttttta agggcaacat cattgaaata atattggtca 15600

gggaccctaa tacagccccg ccatatcata tcccatgaag attcattttt tataatttca 15660

aacatttcaa tcgactcaaa tggcgaatga ttaattacag ctagttgata gaagccttca 15720

tcattttcaa caagatctat tccgtgggga ttgaatatgt ctagctcgcc tcttatgcat 15780

gaagcgtcac cccaagagct ttctccaaaa gtaatttttg gtacctttt ttcataggta 15840

tttaaatcca ttaaggcaaa gtaaccaggg gtatgttctg catatggacc gatccctcca 15900

aattcagaaa taaagaagaa tttattatca ggcgtaatca caatatcttc tgggtttgag 15960

aaattacaaa taaccttgat acggtcatcg gattcacact tactaatatc catttggggg 16020

cctatatagt cagtagatac gacagttaca gaaataaata aataaagaat agaaaccggg 16080

acggtaatct tataatagtg ctttataaaa atttctaaaa tctttgaagc atgatttgga 16140

agtgcgatca gccaaacccc ttttaaaaaa gatagagccc ccataacaac aaaaattact 16200

gaccatagcc tgtcagacca ttccggctga agaagaccag ttaaaaaaag aatcatccca 16260

aagaataaag ctaaatagcc tgagattttg actttcgatc caacaaattt cgaaaagaga 16320

tatgtataaa gaggctttat aagaactagt aaaccacagg ccaagaaaaa gaatgctaag 16380

tagtaattca taagttagtt tttatataaa tgctccttaa taatactaac aagttctaag 16440

ggcttgtcca atggaacatg gtgagcagct ccaggaaccc cctcaaaagt cataatgtca 16500

ccatatgtat ttttaatatt gtccaagata cttccggagg ttaataagct gtcttcaccg 16560

tggatgaaca aagcagggca gccaaatgaa aatgtgtaac cgaataacct ttcaagactg 16620

ctaaacatga catcatcaaa tttccatctc cacccagcct caatattttt tactgagtgc 16680

tcagcaatgt atcttaagta ccaatcattc gtacaatctt gcttaggcat taacctaaac 16740

cttttaataa tatctgtctt gtcttgatag tgcttgatca ttctgagagg agaagagtgt 16800

tgattcgggt cataatccgg tggtcttata aatgtatcaa taataataat attatttatt 16860

agatcctttc tttcagatgc aacgtaacca gcaacatgtc cgccgaggga gtgtccaaca 16920

ataaaaatat ttgaaatatt ttttttatcc ttttcctttt caattacaga gacaatacat 16980

tctccaaaat ctttaatgcc atatgaatct ctaaaagaag agtcacccat gccaggaaga 17040

tctattgcaa ctatatttgc gcagtctcta aagtggggcg caataggatc ccaccatttt 17100

ttatgagcac ctgttccgtg aataagaatt attaaatctt tgctttcatc tttggagttc 17160

cagctagaat aggatatatc cccatgagga ttcttgataa tctctgagct aggcttgtcc 17220

tcaatggcat ctttgaacca ctgtggggca tgaataatgt cttgatttag attgttagtt 17280

atttccataa acagtattct aagctataaa aaataaaaat atgaataaac ttaatttaac 17340

gccagcagca actgttttag tcctaaagga ttctcctgat gggatggaag ttttgatggt 17400

aaaaagatca agtaggcctc ccttcggaga ccttttttgtt ttcccgggcg gcaagattga 17460
cgaaggtgat ttcaataata agatagaaga tttttgtgag ggcgtgactg ataaagaggc 17520
ctccataaat cttggattag attctggagg tctagcatat tgggttgcat gtattagaga 17580
atgctttgag gaggttggaa ttttacttgc taaaaaaaag agtggggaag atcttgatct 17640
agatggagtc gataaacata aatatcaaaa atatagagag atgttgttaa ataatgaaat 17700
tgatttatat aaaatctgtt tagaagaaaa tttaattcta atgcctcaac aaatagcccc 17760
tttctcgcat tggataaccc ctgaaataga aactaggaga tttgatacac gtttttttat 17820
tgcccacctc cccaagcatc agaccggaga acatgatggt agtgagctca tagacagtgt 17880
ttggatttca ccaaaagaag cgctcaaaaa atctcgttcg ggtgagatgc ctatgattat 17940
gcctacaata aaaaatttgg aacaatgtgc acaatttgat tcgggctcta agcttttaga 18000
aaatcagagg aatctctcaa atgaggatat cccaccaatc ctgccaaagt tttttaaaga 18060
agatggtgag tggaggggtc tattgcctgg agataaaggg tatgaggatc attaaataat 18120
atggacttaa ttactaaaat aacagctccc aaccctggtg ttttcactgg gggtgggact 18180
aatacttatt tgattggcaa agatgatata acccttgtcg accctggtcc aaatatatct 18240
gagcatctag atgaaattat caaagcaggg gatgggaaaa taaaaagaat ctttgttact 18300
catacccata cagatcattc cccagccgca ttgcctttat caaaaactct taatgttcca 18360
atgtacggaa ggctagtaga tggtgaatcc tcatgggagg atgaaacatt tatcccagat 18420
attattttaa atgataaaga tattattgag acagacgaat atacgttaga agtaatacat 18480
actcctgggc acgcatctaa tcatttatgc tttttaataa aagatacgaa atgccttcta 18540
acaggcgatc acattatgga cgggtctacg gttgttattg ggccaccaga tggcaatatg 18600
acaagctata tcaattcatt agaaaagtta ctagattttg atattgattg ctttgcgcct 18660
gggcatggaa attatattca tgagcctgag aaaaccattc aatcaattat taggcacaga 18720
ctaacaagag aaagaaaagc tcttagaaag ctaggagagg caggaatctc atcattagat 18780
aaacttacta agcttgttta tgatgatgtg tcagagatgc tccatcctat agctaaatat 18840
agtctagaag cacatttatt aaagcttata gatgaaaaga aagttaaatt agataaagat 18900
ctattcgaaa taatttaatc ctttttattt ttatgtaaga ctttctcctc aatagcttct 18960

atatcaatat catcaattga gtcttcgtta ttatcaggta tcttttttac atcttttca 19020
attttaaggt cgataggaga ggctccaaga tcaaaagtta gctcccttac atttttgaa 19080
atagtatcct caacacagtc atcttgatcg tatgcctcac gggtctctcc tttatcatta 19140
atgggaaagg gtctttgggg agggcccatt tgcatgcatt taatagtagc aactggtgag 19200
tagtaatcgt cactagaata taacttatca agttcttttg gtgatattga gcaaccaata 19260
attccaaata gaataaatgg cgctaagagt cttttcataa actttgtttg ttttctataa 19320
gagactcaac aaccgaagga tcggcaaggg ttgtcgtgtc tcctaaatta gatagatcat 19380
tctcagcaat ctttctaaga attctgcgca taatttttcc cgatcttgtt ttaggcaagc 19440
ctggagcatt ttgaattaaa tctggttttg caatagctcc aatttcttta gcaacaaatt 19500
gtttcaattc ataactaaag ttgtcatcaa atgattcatt tatcattaaa gtaacaaaag 19560
catatattcc ttgcccctta attggatgat caaaaccaac aacagctgct tcagcaattt 19620
tagggtggag cacaagagca ctttcaattt cagctgtacc tagtctgtgg ccagaaacat 19680
taagaacatc atcaactctt ccggttatcc agaagtatcc atcctcgtct cgcctggctc 19740
catcaccagt aaagtaaata tctttataca taccaaaata ggtgtcgatc attctttggt 19800
gatcaccata aatacttcta atttgactag gccaagattg ctcaataact aaattacctg 19860
cattagagcc ttctagcgta tttccatgct cgtcatagag agatggctta actccgaaga 19920
agggcagagt tgctgaccca ggttttgttg gagtaatacc cgctattgga gagataagta 19980
cagaaccagt ttcggtttgc caccaagtat caataacctc gcaattagat ttaccgacaa 20040
cactgtagta ccaatcccac gcctctggat taattggctc tccaactgta cctaaaattc 20100
ttaggctatc tctttttgtc tttttaacag gatcatcgcc ttgggccatc agagctctaa 20160
tggcagttgg agctgtataa aaaatactaa tgtcatgctt atcgcatatc tcccaacacc 20220
ttgatgctga agggtaggtt ggcactcctt caaacataag tgttgttgct ccatttgaaa 20280
gaggtccgta caagatataa gtatgtcctg ttatccatcc cacatctgca gtacaccagt 20340
atttgtcctc tggccttatt ccaaaaagat atttgaaact aatatgagcg cctaatagat 20400
aacctgcagt agtatgtaga acacccttg gcttgcctgt agagcctgat gtatagagaa 20460
tgaaaagagg gtcttcggaa tccataggct ctggagcaca cttattagaa acatctttaa 20520

caagatcttc ataccaaaca tctttttat catcccaatt aatttcgcca ccagttcttt 20580
ttataaccag tgtattttta acatctggac agcccagaag agcctcatct acattagatt 20640
taagtggcac ttttttgccg ccccttaaac cttcatcagc agttataaca attttacaat 20700
cagcatcaag aattctatct ttgagtgatt ctggagaaaa gccaccaaag acaacagagt 20760
gcacggcacc tattcgcgtg caagcaagca ttgcgaacgc agtctcaatg atcataggca 20820
tataaataca aactctcgag ccctttgaa cacccaggtc ttttaaaaca ttagcgaact 20880
tacatacttc gtcatggagc tctttgtagg tcaattcttt agaatcagca gggtcatctc 20940
cttcccatat taatgctatt ttgtttggat cattttctaa atgcctatcg atgcagttta 21000
agctaatatt tgttttacca ccctcaaacc acttcgcatt attaaattga ttattgaatg 21060
ttgttttgaa gtcttccatc cagcttatgt tttcgtttgc tagattttta aaaaatttag 21120
aaggatcttc tatggattgc ttgtaaagtt ctttgtattc atcaaagtct tttatataag 21180
gattacttga atgttttggg ctataaagct ttcgaggcat tcttaaataa ttgaaggttg 21240
ggggttaatg aaattctttc ctttgggatt ggacattatt tttgtaatga gcgattcgta 21300
atcgctatca ttggtttcta aattaatatc tgcagcatta attattaata aaggggcaga 21360
actatagtct aagaaaaacc ttgagtatgc atcattcagt ctttccaggt agtcaagagt 21420
tagatattgt tcgttaatat ttcctctctt agtaatcctg tcttttaaca catcaatagg 21480
tgcctgaaga tagattacta ggtcgggtgt tggcgcgtcc agggttagat ggtcatatac 21540
tttgtcatat agatccattt cctcgttaga aagagtaacc tcagcgaata atcgatcttt 21600
ttctattaaa aaatcagcaa ccctcactgt ttcaaaaagg cttctttgtt taagatcttg 21660
aatttgttgc attctttgaa acaagaagaa aagctgagtg gctagagctg attggcttgg 21720
gtttttataa aaattcttta agaagggatt ctctgccggt tgttctaaaa aagaatcata 21780
attaaatgtt tcggctatct tatttgctaa agtagttttc ccaacaccta tcggtccttc 21840
aattgcgata tattttggaa gtggtacttc tttaatagct gggttcattt ataacgtata 21900
gtttttatcc tagattatct caactcgtta tagaagccaa atatttttgc agattcttca 21960
tcacttttt cattcatctc agcaataatg gttcctctca atgagtcatc attttttgg 22020
aaatcagtcc accacttccc aataccactc ttgtctccag aagctctctc tcttacaagg 22080

agaaaatcat atgcagctct aaaccttgga tgtcgaagag ttttatatgg ctggctacca 22140
attctgctat gaagttttaa ttgaagtacc caaatatcct taatatagct tgaaaatttt 22200
cttggtattg ctgtgatttt ttgttgttcg cgaagtacac catccataga tcggaaaaat 22260
tttctcacat taatttctcc attcttagaa cacttttca ataacgaggg ccataacaat 22320
gcagccataa gaaagcctgg tgtaattgac tgttggtttt taaccctatc atcagtattt 22380
cttagagcat gtgtcataac attgctggca aagtcattcc tacttggatc agaaaggata 22440
agatatttat ttaaatgaaa tgagcagagt ttttcaaaat tcttttcacc cattccattc 22500
aaaaatattt tgcagaactc atcaaacaat ctagcgtttg agatgcctga taaaagatgg 22560
cctttatcat agatggcatc cttaaccaga ttatctatct taaaattgag tttgttacta 22620
aatcttatag ctcttaagct tctcactgga tcttcttcga atcgtctttg gggatctcca 22680
atagatacaa taaccttctt gtgtatatgc ttaagcccat cgttatgatc ttctattttt 22740
tttgtaacag gacagtagta aagggcattc acagtaaaat ctcttctatg acaatcttgt 22800
tcaagagtgc cccaattatt atctctaaga atctttcctg tcgaatcagt aacaatattt 22860
tcaccatctt cctgatcact tcctgatctg aaagttgcta cttcaagcaa ttcactccta 22920
ttaaaaacat gaaccaattt aaatcttttg ccaattattc ttgaagcttt aaatgttttc 22980
ctgatctgct caggcgtggc attagtggct atatcgaaat cttttggctc tagtcccgtt 23040
agtgcatcgc gaacgcaccc accaaccaga taggcctgaa aattattttt ttgaaggtct 23100
tgaacgacag atatagcaaa tttacttatc ttattattat ctatcaaatc taattatgaa 23160
tttttatgat ttaagggcat tagccattta gctgcttttc tttaatttcg tcaagtgttt 23220
tgcaatgaat gcaatgagtt gcagttggtc tagcttcaag cctcttaatt ccaatttcat 23280
caccacagga ttcgcaccaa ccataatcat cttgcttaat ttgttcaata gatagaccta 23340
ttttgctgat aagttttctc tctctatctc tggttcttaa ttcaaaagca aactcttcct 23400
cttgagaagc cctgtctact gggtctgcat aggtttcacc tttagctcta agatgatcaa 23460
aagtttttg catttcatcc ttaagatgtt ctttccaaag aagaagaacg gcaacaaaat 23520
gtttcttcat tgctgcactc atatattttt caccttctt agatttataa ggtgcaattt 23580
tagatttatt attagctatt gttgcttttg cagacttctt ggctgcaact tttttaactg 23640

gagcttttt ggtaacagtt tttttaactg tagcttttt ggcaacagtt tttttaactg 23700

gagcttttt tactgtcttg gattttttt cgaccatgta agattttata gaattttagg 23760

gtggagaaaa tatcagatac tgacaaaatt agctagtcat tttttaattt atttaatact 23820

ttcaagtacc catccgagct aagtcttggc ccaaatgtct caacaacctt ggaagatgca 23880

tagtttgcaa acttagcaca tgcttcaata ttattccctt gaaggtaggc atgcataaac 23940

gatccggcaa acatatcacc agctccattg gtatctattg gagttatttc ttctgcttga 24000

gcatgcttct caacccctttt atctataaca acacttccat cggcgccttt tgtaatagca 24060

gtcatatagg gcttttcttt ataaaagcta acagcatcat caaggctttc tttaccagaa 24120

aaagcaacag cttcatcatc attacagaag atcatatcta ttccatatga ctctattaaa 24180

tcaaattttt ctttaaaacc atgaacaata cctgcatcag aaagagacaa ggctttcttt 24240

acgtccttgt ctttaaggtg ctctaagact gaaataacag cattaaagtt atcgtcactt 24300

gttaccatgt agccttcgat ataaaaaatt tttgaatttt ctacaacatc aaaatctata 24360

tctgatttac caagatacgc actaactcca agcatgctgc tcatagttct cttagcgtca 24420

ggagtaacta aaattaagca tttcccagtt ggttgatctg tattttcaga gctgacacca 24480

atatgtttga ctccagccga cctgagacta tcaagatagt ttcttccatc ttcatcatca 24540

gaaactctgc atacatgatg gcaattcgaa ccataatttg ctgcagcaac aagagaattg 24600

gttgcagagc caccgcaatc agaaatcgat tcggctccca tttcaataag tttgctaatt 24660

ataggtgcct gttcttcaga agatgaaaga gtcatagagt cggctacaag gcctacactt 24720

gataaaaatt catggctgac tttatattga gtatctacta aagcatttcc aagggcgcta 24780

atatcatatt tcatgtgtta ttccttttg tattatttgt tttactgttt ctaacgttct 24840

attaatttct tgatccttat gcattgctga aatgaagcct gcttcatatt tagaggggc 24900

aaagtatatt ccacttctaa tacatgaatt taaaaaattt gaaaatagta catcatcagt 24960

ttttgcaaca tcattaatat tattagggag ttcttctgaa aaaaagaatc cgaacattcc 25020

accaattctg tttatagaaa acggaatacc tgactcaatc attaaggttt tcatcccatc 25080

caaaagcaca gatgcatttc tttctaactc tttaaacgga ttttctttaa tcaacaattg 25140

caacaaagca gttcctccag ccatagctag tggattgcca gacaaagttc ctgcttgata 25200

gacaggacca gaaggagcta gatagttcat aatttcttct ttgcctccaa aagctccaac 25260

aggaagaccg ccacctatta ctttccccaa agcagttaag tcaggagtaa tattataaat 25320

ttcttgagct ccgcctagcg aaactctaaa gccgctcatg acctcatcaa atattaaaat 25380

agaattattg gctgaggtgg tttccctcaa taactttaag aaatcttcat gacctggaac 25440

aaagcccata ttccctgcta ctggttcgac tattacggcc gctaagtcat cttttatctc 25500

attaaatatt tctaaaaact gttctttatt attgtattcg caactaaatg tatattttgc 25560

caaatctgca ggaacccctg gagagtcagg taagccaaag gtggcaaccc cagaacccgc 25620

cttaattaaa agagagtcaa catgaccgtg ataacagcca tcaaatttaa taattttatt 25680

ccttcctgta aaacctctgg ccaatctaat cgttgtcatg gttgcttcag tacctgaatt 25740

aaccattctt attttttcaa ttgaaggaat gcatttttta attagcctgg ccacatcaga 25800

ttcaagactt gtcggggcgc cataactagt tccaagcgca acttgatttt taattgcacc 25860

tacaatgtct gggtgtgaat gacccattat catcggaccc caagacccaa tataatcaat 25920

atattcatta tgatcagcat cataaaggta tgcgccggat gctctttcaa aaaatatagg 25980

attgccattg atatttttga atgcccttac tggtgaattt acccctccag gcataagagt 26040

cttggcctct ttgaataagg ctatggattt atcaatttta ttatgtgtca aagctaattc 26100

ttcttaattt ttaatttcga tatgatatca acttaattct tattatgtat ttaattgttt 26160

tgaaaattca tccacagtat tccagttggt gaactcataa gtatttgtaa catctgtagg 26220

acccttttgta atccacataa tcaatctaat catgtgttta tctataaatt tatattttgg 26280

ataatctatt ttgcctgcaa agactgctaa tttcattggg ttccaaggag acagctctaa 26340

aaatttttgc atatacgggt ttgtttcagg tgtatttttt tcaggctttc tcgcaactac 26400

attaactgaa aagaaggcat tttcttttgt ttcaagacaa gcaacatttt tttgaataaa 26460

ttcataaagt tctggtttgt gtttgccata cctaatgctc gcaccaataa taattttatc 26520

aaattgatat aaatctaact ctactgcttt tgcaatatgt attatttttg aagattcaga 26580

cacatctaat ttagagaaaa ttttttttaca aatttccaga gtttgcccat cggttgtaga 26640

gtagattagt agagttgatt tcataaatat attttatatt gttaattaaa aaatttcatg 26700

gcacgcgcaa aatataaaca aaaatatagt atatttaaaa aatgattaaa tatttattta 26760

ttatcgcttt attcatcagc aactttgcat atgcaaatat tgatgcagct aggtgcgcag 26820

ggattagttc agatcaagaa agacttgatt gctatgattt aatttttaaa gctaatgatg 26880

agctaccttt agatagtaat attaaaactc tcatcacacc agctatcaag gctgtgaccc 26940

cagctgattc aataaaaatt gaaaataaag caacaaaaga aaaggatttc gggcttccaa 27000

aaacaaaaat caaaaactct gcaaagaact caataaaaac ctcggtagta aggattaaaa 27060

aaacaaaaag tggtaaatta atttttactt tagaaaatga gcaagaatgg actgctgaaa 27120

cttcttatag agcaaggaat atgtttaaac cagaaaccgc agtcatttta gaagaggccc 27180

tggttagtgg tttttatatg attaatataa gtaataaaca gaaaattaga ataaagaggt 27240

tgaaatagca atgaccatac agagtatagc aacgaccgag ggtgccatga aaagaataag 27300

atctgttctg gggtcccaag atggctcaag cttcagggtt tatgttaccg gaggtgggtg 27360

ctctgggttt caatatggct tcaagtttga taacgatatt gcattcgatg atgatgttat 27420

aaattgtgga gatttctcgc ttttaataga ctctatgtcg tacccctatc tttatggatc 27480

aactctggat tttgttgaag atctctcagg ggctaaattc gttattaaaa acccaaatgc 27540

caaaacaaca tgcgggtgtg gagagtcatt tacagtttag attttgtaat tgaacccaaa 27600

agtcctttta cattcttgct tgatgtctga actatcagag cctcattact gactctttta 27660

tatcccatcc aggcaaatgc catggactca atagcaaaaa catcatggcc taaatcactt 27720

gagaggacga tatcattact agccatctca gaaattcttt ttaccagata cttgttatgg 27780

gcaccaccgc cacaaatgac aatgtcacaa ttattatgac cattttatg gattgaattt 27840

attatagatt ttgctgaaaa ttcaaccagg gtacatagaa tatcttcagc tttcttttt 27900

aagaatttct tggataatat ttttatatta aagagctctt tgcctgttga ttttggacat 27960

tttcttttaa aaaaattatt ttgaagcaat cttcctaact caatgtgatc tacttttcct 28020

ttggctgcaa ttgcaccatt tttatcaaaa ggaatctgaa gaaaatcact acaatatgca 28080

tctaaaattg cattaccagg gcctacatca gttccccata tgtcatttct atttttaca 28140

aatgagtaat ttgaaatccc ccctatattt aaaataattc gtgggtttct agctttataa 28200

aataattgat tatggaattc cggaacaaga ggggcgcctt cgccacccag agcaatatgc 28260

atatttctaa aatcacttac caccagaagg cccgtttctt ttgcaacaat atttggatca 28320

ccaatttgca tagaaaatgg aaatctctta ttaatttcat gcctaatggt ttgtccagaa 28380
atagcaacac actctataga tgatttctta attttactaa atccaatcgc ctcattaata 28440
gattttgaaa ataagaatcc tatctcttta ttgatagtgc ctaaatctga caacgagctt 28500
tcgttatttt caataagttt ttttactttt aatcttaggg attttgggaa tttaattgaa 28560
tggaaatact caagatgtat ttttgtacca atgctaagaa atgaaatatc aatagcgtca 28620
tgactagttc ctgtcattgc tccaatatag atctttttac tcattactac ttggagaaag 28680
tttattgaac tcctccattg ataatttatt attctttaat agtgtatcaa aacttgccct 28740
taaatttttt ggtactggtt cagctgatgg taattttact tttataggat ctattctttt 28800
cttacctatc ttaaactcat aatgtaaatg aggccctgtt gccagtcctg aactcccaac 28860
gaaaccaata gtatcgccct gagaaacttt tttgcctttt cttataccct tactaaattt 28920
ttctaaatga caatatctag tcgaatactc atttgtatga tttataacta tctcattacc 28980
acatccattc ctttgaccag aaaaagaaac aatcccatcg cctgtagttc tcaccggcga 29040
tcctcttttt gctgcataat cgactccatt gtgagctctt attgtatgaa gaacaggatg 29100
cattctgttt ggattaaaat gagaactaat atatgcaaaa tctaaagggg ctcttaaaaa 29160
ggccttttgc atattatttc cattttcatc aaagtactgt tttttactgg cttcagtgaa 29220
aaacctattt gcaaaatagg tattaccatt gttaataaac ttagcaatta cgatatcgcc 29280
atttttttact ttctctccat cactataagg agtgtcataa attacatgaa attcgtcacc 29340
ctctctaata tcaaaaacga agtctacatc ccagccaaag atataagcaa agtccataat 29400
cacactttcg ggaatatttg catctagagc tgcctcataa aatgaggatt gaataatccc 29460
gctattgtaa gattcaatta actcaatact tttgcttata ttcttaaata ctatttctgg 29520
agtaaggcta attgaaatag aatttatttg atctttcatg atctcaattc tggttagctc 29580
ctcaccagaa tattcaaaga gcatttttc ccctggttta atgttagcaa tgatattttt 29640
ggagtctaat ctaaaaattt tataagcagt atttaaaggc actgaaaagt tttcaaaaat 29700
tattgaaaga ttttctccat cttgcacctc atgcatctga tatgttttcg tttgctcgag 29760
aggtatagag aatttttcag taatctcaat ttcttcaact ggcaaagatt catatgtttc 29820
tatatcaata taaagcatta atattaagac aatagaaaca gcaaaagaaa caagtaccgc 29880

tcttttgga actttttaa aacctatcat tagtcctctt gaatatttaa gagttcagtg 29940
ttgccaccaa atgctaccga gttctttgag acaacctttt cgttaagaaa ttgcagaagg 30000
taattaggcc caccagcctt ataaccgctg ccggatagat tttgtccacc aaaaggctga 30060
gaaccaacaa cagctcccac catatctcta tttatgtaaa tatttccaac attacacttg 30120
tcactaaata tgtcggccct tttttctact ctagtatgaa tacccattgt aaggccgaag 30180
ccactatcat taatattttc aattagtgca tccatttcat ttgatttaaa tctaacgata 30240
tgaagtattg gtccaaattg ctcgtctttt agatcagaaa tattatcaat ctcaattatt 30300
gttggagcta caaaattttc atctacatta tcagcagacc taaaaataga ataattctta 30360
tcttcaaaac ctttgacgta agcattgaga ctatcaagag atgttttgct aattattgga 30420
ccgatatctg tgtcaagatt ttgagggttt ccaattttta gttctttcat accaccctta 30480
atcattgata aaagatcgtc atatatttcg tcttgtacac agagaactct caaggcagag 30540
catcgctgtc cagagctatc aaatgctgaa cgaataatat catcggttgc ttgctcgaga 30600
agtgcgcttg aatcaacaat cattgaattt atgcctcctg tctctgcaat caaaggaata 30660
attgattcat ggttacttgc aaggctgctt tgaatttttt ttgctgtttt taaagacccg 30720
gtgaatgcaa ccccttttgat gttattaacc tttgaaagca tgtcaccatg aatgccgtct 30780
cctaggatta aatttaaagc atcttttggg accccaatct catgaaattt gttcacaatg 30840
atgtagccaa gaattgaagt atgttctgag ggcttaactg ttactttatt tccacatgca 30900
agggctgcac ttatttgccc tataagtatt gcaacaggaa agttccatgg actaatacat 30960
aaaatatggc cttttggtga gtaagatagg gcattgatct cgccggtggg accctcaaga 31020
atatggtctt ctgtttggag gccaacagct tgttttgcat agtatctgag aaaatctata 31080
gcttctctaa tttcatcaat agtattttgt actgtttttc cggcttcatt cataaggtaa 31140
taaattagct cagaaggatt tgcttcaatg tcgtctgcaa ttttttctaa aatggatgct 31200
ctttttttcaa catgcatcaa agaccattca ctaatatttt gttcttcaag gctgcccttt 31260
atataatcta gatcatcata tgaggctgta ccaatatttc ttccatctgc aagagatgag 31320
atgtcatgag tattggtttt cttataatcc tttgctttat aaatcgatga agcctttatt 31380
tcttttgaat caaactttcc aagctcctct tcaagcattt ctaaattcac cctttcactt 31440

aaatcaaatc ctttagagtt cggtctgtca ttaaatatat ttcttggcat tggtatctct 31500

ttttttttcat cctcaatttt taaatggggc cctctggcaa gccaagcaga atctgtttca 31560

ggatcaagta acctattaat aaatgagctg tttgctccat tttctaatag tcttcttaca 31620

agatagggta gcaagtcttt atatttgcca atcggcgcat aaattgaggt atttttttca 31680

gtatttaaga ttttgtttgc ggacttataa agcagctctc ccattccaaa tagtctttga 31740

aattcataat ccttatttga gccaagatga tggattgcag aaatggtatg tgcattatgt 31800

gtagcaaatt tagggtaaat tttttccaca ttaaaaattc tttttgcaca ggctaaataa 31860

gctaagtctg taacagattt ttttgtatag acaggataac catcatagcc atagatttga 31920

gcatgcttaa tttcataatc ccaatatgct ccttttacga gccgaacatg cataggtgct 31980

ctgttttcta gtagctcttc taaccaatct attgtggcta tagctctttt gccatatgcc 32040

tgaacagcaa taccaaatcc tttccagttt ttaatatttg gtgaaagggc catctcttta 32100

ataatctcta aactaacggc cagtctgtct tgctcctcag catcgattgt aatttctaca 32160

tctttagact ttgcatactc tgtgagctga ataagttttg gaagtagatc agactttatg 32220

tcttttagct ttttcatttc atatctagga gataaagctg atatttttat tgagacacca 32280

ttaattgtat tttttgtcag atttatcttg ccgacttcat ctatagcatt cttataagac 32340

tgataataag tgtcggcttg ttcagcgttt cttgctgcct ctccaagcat gtcaaatgaa 32400

taaatttcat tttctatatt cttaattttt tttatgtcat caaaatctct gcccataaca 32460

aattcttgac tgagaatatg catggcacca actacagcat ttctaattgg aaactcgcca 32520

gattttgaga ttaaagaact taatagggcg cttgggtttt tggtccactc atcgggtgta 32580

gaaactacct tgcctgcaag aagaagaccc catgttgatg cattaacgaa aacactatcc 32640

gctttgttta aatgctctat ccacgcaccc tcagataact tctcagatat tattagatcc 32700

cttgtttttt tgtctgggat tcttagtatt gattcggcta aacacatcag agcaacacct 32760

tctttattat ctagcccata ttcgcttaga aatgcatcta gttttgttct ctcgctctta 32820

ttctctctgc aagcatcaat tattttattg agcatttttt gaaatcgaag ggtcatttaa 32880

aaaatcagaa ttactaataa gatctgaaac tatttcttgt tcaggataaa acttgttact 32940

tgttaatgtc atagctatta ttttaatctt atagtgccaa gtatcaactt actgattcta 33000

ttaatgactt aaaaacatta tgatagtcat atgagtgatg cacttaaatt aattaaacga 33060
ggaaccgacg agatcctcac agagtctgat ttaaaaaaga aattagattc tggaaaacag 33120
ctaatcatta aggcggggtt tgatccaaca gctccagacc ttcatttggg tcataccgta 33180
ttattaaata agctaagaca ttttcaagat cttgggcata aagtaatttt tctaattggt 33240
gattttactg gtcaaattgg agatccctcc ggtaaaaata aaactaggcc aacacttact 33300
tcagaagaat taatttcaaa tgcaaaaaca tatgagaaac aagtttttaa aattcttaaa 33360
aaagaattaa cagaagttaa atttaattct gagtggtgca acaagcttgg tgcagatggt 33420
ttgattggtc ttgcatcaaa atataatgtt gcaagaatgc tggagcgtga tgattttaat 33480
aaacgttata gcgcaaatca aagcatagct attcatgaat ttttataccc ccttgttcaa 33540
ggatatgact ctgtagccct agaggctgat gtcgaatgcg gaggaacaga tcaaaaattt 33600
aatttgctag tagggagaga gctacaaaga tcctatggtc aagaacctca ggttgtttta 33660
actgtaccca ttctagaagg cttggacgga ataaataaaa tgtccaaatc attaaataac 33720
tttatagcaa tagatgaaga gcctaatgat atgttcggta aaataatgtc tatttcagac 33780
gagttaatgt ggagatggtt tgagttactc agctttacct cagagaaaga aataggagtt 33840
cttaagaaga aaatggaaga agggaccaac ccaagagata ttaagtttct tttagcagaa 33900
gagttagtag atagattcca ttcagagggt gatggttcga aatgcaagga agcttttctt 33960
caaagatttc aaaaaggtca aatgcctgat gacattcctt ccatgtcagt tgatgttggg 34020
gctgagggca ttccattagt aaaccttta aagaattgtg agatgacatc aagtacatct 34080
gaggcgatga gacttgttaa acaaggcgga gttaaaatcg actctgtaaa aatagaagat 34140
cctaaaatgc taatttcaaa aggccaggag tctatttatc aggttggcaa aagaaaattt 34200
ttaaaaatta aaacataatg aaaaataaat tagtccaaat atttcttctt ctttttatag 34260
ttgcgtgtaa tcaggatagc cctaatatta aacaaattag taatatgcag tattttattg 34320
ataatgaaat aagggaagga atctattctg ttgaaccagg cttgcaatac tcaattatcc 34380
aaaatggaga tcaaagttct gaatcaccat tgctgcagga tacaattaca gctcattttc 34440
acgggaccct cactgatggc tcagtttttt ggagttctgt tgaaatgggt gagcccttaa 34500
cagtcgaact atcaggtcta atagttgggt gccaaaaaat aatctctatg atgaagaaag 34560

gtgatgaatg gagagtttat atcgacccaa gtatggccta tggcgatgag ggccggcctg 34620
ggataccttc aaactcaatt cttatttttg atattgagtt attagatatc caaaaaaact 34680
aacccttatc tataacggat agagcgtatc cataaacctc agcaacctgg ttaataattt 34740
tatttttagg tgttccggct ccatgaccag ctcttccttc aattctaatt aatattggat 34800
tatcacaccc ctgggactct tgaagttttg ctgcaaactt gaatgaatga gagggtacta 34860
ctctatcatc tcttttagct gtagtaatca gagtagttgg atagcactca ccttcaacaa 34920
tattatgcag aggcgaataa gctaataagt tttcaaactc atctttctta tctggagagc 34980
catagtcact ttcccaggcc cagcctatag taaatttatg aaatctaagc atgtccaaga 35040
cgccaacttg tggaattgcg actttaaata aattaggatt ttgcaacatg gtcgcagcca 35100
ctagcaaacc tccattagag ccaccttgaa tagcggttga tgatggagaa ccaatttctt 35160
gtgcgtgtaa aaatttagca gaatatgcaa agtcatcaaa aacattttgt ttattaaaaa 35220
gcctgcctgc atcatgccag ttatcaccat attcaccacc acctcttaga ttaactacag 35280
caactattcc cccttggttc atccaagtga ggtagctttt actaaagcca ggtagtcttg 35340
agatattaaa gccaccatat ccatataaaa gtattggagt attactgtct atttttaagg 35400
acttttgta actaagatgg atgggtattt gtgttccatc tttggatgga aagaatttaa 35460
agtcagatgt aaataaagtt gagtcgtgtc ctttaagatc ttctttccaa aaaagttctt 35520
gtgacatatc agttagatta attttgtata tttctcgagg agttacaaaa tttgtaaatg 35580
aaaaataaga tacctcatct tcaatttcac caccaaaacc acccattgtt ccttttcttt 35640
ctgttgctag cttattttta tatgctcctt ttaaatcaaa gaagtgaacc tcagtaaaag 35700
tatcaacgag ataagaaact acaatagaat tatttataaa gctaacacta ctaatagaat 35760
tagtactttc accaacgact tcattccaaa caaatgagcc atttttatt gtaagtgata 35820
ctacttttcc gttcgcagca ttttcagttg agtaaaacca aaaagtatca ttcttgcttt 35880
ctaaaaagct ataagcgcct attagctcat ctattaaagg aataaaaggc tgatcagggc 35940
ttagctgaac atagagtcta tttctttcat ctgtgccttc accaatagat agaaacttaa 36000
ttttagaatc ttttacaaca cttattcccc aactccatct tggcttttca ggattctcat 36060
aaacaatcac atcctcatct tgagcagtac caattttatg aaacattaac tttggagctg 36120

tattaatatc ttttaaaagc tcttccgatg gctcgtcgta tttttggtaa taaaatccag 36180
aatcatcatt ttcccatgaa gcaccagaaa atttagccca ttcaatccta tcatcaagag 36240
tttttcctga ttcaatatca agtactttcc aggttctcca atcagaccca ccatctgata 36300
ttgagaaagc tagaagagat gcatcattac taacgctggt acttgcaaga gagatagttc 36360
catcttctga gaactgattt ggatcaagta aaactctatc ttggcattct tcacagtcct 36420
taatcatcag cttgctttgt tgccatgacc catcattgaa ataataaaaa gttttttgt 36480
taacctgata aggcatgctt atcgaatctg tatcccaaac ctcatctaaa ttcttagcaa 36540
tagatttttt atatttattt tggcctataa atttttgtgt gaaattattt tgtctctcga 36600
cccagtctgt tgagtcctca cttgtaaaat cctccatcca tctataagca tcttcgatta 36660
ggtatccatg gacttcttca ctaaaaggaa ctttatttga ttcagggtat tcaaaattat 36720
ctgtttgatt tgagcaacta actagaatta atagagctgc catgtatatg tatttattgc 36780
gcataaaaag cataatactt tacaattacc ttatgaatca attcaatcga gcatggcaac 36840
ttttacgcaa aaaattggaa gtttttttatt gtacttgccg cacccatcat gatgcttgaa 36900
atagcaatgg catcaatggt aaccccaata caaaacgtta ctcagcctga ggatattcta 36960
gaatttttca atgagaatat agcctttcta ggctctgtta gtctcttagg cgtagtttta 37020
agtatggctt ttatgggagc gcttttttgtt tcgtatgcat ccatagaatc agaaaatgag 37080
attgagcctc taaatgcctt atttttaggc ataagaaaat tctttccact tctgggggct 37140
tatcttatag cttcagttgg tgtctttttt ggtatcttat tattaatact cccagctttt 37200
tatgtagcag caaggctttg catttttcct gcatttatta tgcttgaaga caaaggagct 37260
atagaatctc ttaaattatc ttgggaaaag acggatgagc atggcaccac tttgtttggg 37320
cttaccatta ccttcttttc tttaacaatg atttttgcat cagttgccca atccattata 37380
agtccgggat taatgcaatt agttgttctt gcaattattg aatatgtaat agtaattcca 37440
tggggctatg tatattttag tttatacaag tcattaaaaa gatattaggc agattaacta 37500
gaataaatta atacgaagct tttcgtttac aaaaaaacac accactctta taatccttcc 37560
tccgaagatt tgcactttgt taattcatgc aaacaacttt gggtctgtag ctcagcttgg 37620
ttagagcgca cccctgataa gggtgaggtc ggtggttcga gtccacccag acccaccatt 37680

ctttgaacat taacttttat ttcctttata cttattctta actaaataag gatagtatta 37740

tggctaaagg tttagacaag caaaaaaacg acaagaagaa aggcaaaact ctaaaagaaa 37800

aaagagcggc aaaaaaagaa aaaaagaaat agtttttttgt agaagactat tattatctag 37860

tcgacctagg gccatcttta aaatctattt taaagaacaa cattattccg gtcactgagc 37920

ttactaaagc taaaatagaa aatattttta aaagaaggtt gtcgatatta tctctttctt 37980

tccaatccat aatatgaaac ccccacatca gatcccatat tttccattta ttagatctaa 38040

tggccacaac ctctgctgag taaacattaa tgtaaacatt taattcagta cctttaacat 38100

ttttactttt tactctataa attggcaatg atctgcctct atattcagat cctgattttt 38160

catttacaac ttcttcggta gcaaatggca aaagagttgt ttggcttgaa actgaatcta 38220

tagcatcttc catagaaatc tttgttaaag gctgcccaag catattcaga tacttagttg 38280

agccctttgt tgtgatgata acaatctctt gacctaatct ttttttgaat ttaacttctt 38340

tagctttctc tatttcaaaa tttaacttac ttaaatcaaa agatgtttca acatgattaa 38400

ggtattgctc gcctcttacg agctcaatct tattaaaagc aaagtatatg cctgagatag 38460

tccaaagtaa taactgaaga gagataaaaa aacttaggta cttatgaatt ttcctaacta 38520

aaaagttcat cttttcataa tcttcattat ttcatcaatt tttacatcaa attcgtcatc 38580

acctttttaaa gattccttaa tgcattcacg caaatgggtt tttagaattt tgccctcaac 38640

agtaataatt gaattcttaa gtgcttttat ttgattaaga atatcaacgc agtattgacc 38700

ttcctcaacc attccttgaa cgcctcgcac ctggccctct attcttttta agcttattaa 38760

ttgctcttta tgacatggat gtttcatttt ataaaaacct cggaactata tacgtaaaaa 38820

ttgtagcgaa taaaaaaatt gctacagatg catagtacag atacctagat ttttttctag 38880

tttctgaaca tgctctgcct agttctgggt cagcagggca aggcatatga taagttttgt 38940

agttgatata tcctgcaatg acaatcatta ctaatgcaaa tagtgttatg taaagcttat 39000

attgagatag ggtaattaag aatggaaata cagttaccag gcttgcaaaa cttgccccag 39060

caccaagagc aacaaaaata gctggcaagg cacaacatat caaagtagaa gaagatgcaa 39120

ataatgaaaa aaaattcgac gccttatcat tcatagttat taaatttcta ggatttgaag 39180

atcagacata ttttggccat tagaaagaat cttcttttcg atctcagaga aggtgatttc 39240

ttttgcctta gaaaaggcaa tcactacttt tccattatca agatcaacat ctattctttt 39300
gacatcttta tcttttagaa aagtttttga aatacctctt gcacagaaat cacaaaccat 39360
tcccttcacg cttacgatcg ctatatttac atttgagagt ccttcaacaa atgcatcaaa 39420
cctctcaggg tttacatcaa gatcttttcc atcaaccatg gtttcatgta aatgaccttc 39480
atgagaatgc ccatgcatac cactatggtc attctccgcc gcaataaggc cgcttgaaag 39540
caaagtaatt aataataatt ttttcatatt tttctccttt taaaatctgt acataaaatg 39600
taaatcccag ctcgtatctg cgtcatagcc aaactcaaca agggcattac cataaaaaaa 39660
tttcaattct ggatacgtag atgatttatt tgttacagta ttttttttgg ttttaaccat 39720
aacccatgta tgtaaatcat tgtagtcagc aacgtaagga gcaaatccaa gttgaatata 39780
ttcttcttta tagtctttgc taaatttact gttaatatcc tttaacccaa agcccgcata 39840
ccacttccgg gtttcccagt ctccatggat accataaaaa ttatttttaa tacttccagg 39900
cacaattcct gattgaaaat ataaattcct ttgggatgta aaagtatttt ttctattcac 39960
caaataagta aaacgaaaat agttttctgt gttcttataa aatttatttt tagccctttc 40020
taggccaatg gaatatttgt aggttggaga gtagtggaaa taaatagaat cattaaaggt 40080
atctgattta tacattatgg ttgttccgcc agagtaggat atcggtcttg catcagcatt 40140
aaagaccatt aaaaaaacta aaatgattat tttatatata cccatggggg gtatcttacc 40200
ataggattat aaattaattt caggcatctc tccaagcgcc cattttcaat gaaatcacca 40260
tcagaattcc aaaaataacc atagctatag cagatgcata aaaaatacta actagcccat 40320
atgagagcca gtaaacagct accaatgcta taacagaaaa tactataagc ctgatggccg 40380
tgattataat tggccatttc attgcattgg ctccctgaga tgcaaaatac agggaaagcc 40440
catatccttg aaatacataa catacaccaa ggatttgaat atactgcttt gtaactaata 40500
aggtctctgg atccgatgta aaaatactaa tccaaagatt tggtgttagt gctaaagcta 40560
gaccgataac agccgaaagc aatccagctg ttgttgcacc aaccatgcct atttttctg 40620
ctcgctctat atttttggca cctatatttg ttccaaccat ggctgtcata gcagtcccaa 40680
tgccgaacac aattgggatt aataagaact ctacccttga accaattcca taaccggcaa 40740
tagcagacgt tccaaattga ccaatgagtc ctgtcagtaa aagaactgtt gcaactgtca 40800

ttattggcga aagagatgcg ggtaaggcaa cagaaaaaat atcttcgaat aattctcttt 40860
caattgttag tcttttgagc ttaagcctta caggcgatga agggctcgaa atttttatta 40920
aagttactaa tgccataaaa cctgaagtaa ctatcattga ccaagcagat cccacaagcc 40980
caagtttagg tagaccgaat gatcctaata taaatccagc agagaaaaaa acttgtatac 41040
ctgcacaaat taccgttagg actgcaggaa attgcatatc tcccatccct cttagggcgg 41100
cggttaagct acctgatagc caaacaacta ttgctcccaa taaatagaca aaacaataag 41160
ctaaagactc ctctaataat gcacctgttc cacctaatat tcttaataga ggctctccaa 41220
aaataaaaaa gataattaaa aaagctaaag ctccaaagca agatatatac aaagaatgcc 41280
ataataattt ttcagcccta ggcttgtctg cggctccaag acttcttgca atagaagatg 41340
tgaccgctcc tccaagagca ccaaatgcca tctgctgagt cagcatgatt gcaggaaatg 41400
ccaaagtaac agcagctaat ggagttatgc caagttgact aataaaccag aattcagcaa 41460
gaacaaccac agcatttatt aaaaatgcaa cagtattagg tgctgacatt ttaatcagca 41520
aaggaaatat tggatctttt aaaaattgct ctgttctctt gtccataacc ttctcattta 41580
ttaatattta tttggttaaa gggtgaaaga gaacacgttc tcaggattca cgaatcttta 41640
aataataata acagctttta gttaatttaa tttttaaaaa caaccaaatc tattatctgc 41700
tagattttat tttttaaaca tattaatatc taatttaatt gcaaaggggt ggccatttcg 41760
gcctgagatc cttggaaact ctttgaacct gatccataca ataatggcgg aggaattgca 41820
tgaaaatcat taaaaatcat ttatttttatt caataatctt actatatttt tttagtctag 41880
agacgagctc tcaagctata gaagaagtta ttatcaaagg agactggaga gaaactagtc 41940
tgtcagcaga agactcaagc attgcagtcc ttgatagtaa attaatagaa tcccaggctt 42000
taaagcactt tgaaaacctt tcgtacctag taccaaattt aaattttgct gcaagtgatt 42060
ctagagcaag acatttccag ataagaggaa ttggagaaag atctggctat gaaagaactc 42120
caaactctgc agtaggttta ctgattgatg atatagactt ttctgggcaa ggtggaattg 42180
ccacaacttt tgatgttgat caaattgaag ttcacagagg cccccaagga gcaagaatag 42240
ggtctagcgc aatggcgggg ctcatatata tttctacaaa agacccaaca gaaagctttg 42300
aagggaaggg tgaaatagtt atggggtcat atggaacttt taataccgga attgctgttg 42360

gcggtcctgt aaattttaat aaagacctca cttataggtt agctataaag aaagattatt 42420
ctgacggatt taggaagaat atttttctca acaagtctga tacttctaag aaagatgaga 42480
gcacatttag attaaaagtg aattgggtaa ctgataacca aaccacttat aagtttctta 42540
tatctcaaat agagttagat gatcctgcag atatatggac tatagatggg agtcttaata 42600
cattatctga taagcctgga atggactctc aaaaaagtaa tgcctatggg gtaaaaattt 42660
atcatcaatt taaaaaattt gaatttcaaa gcctatcaag cttaacgaat actgatgtca 42720
ttcttagtta tgatgctgat tggggcaacc ctgagtcgca ttcacccttt atttatgact 42780
atttttcaga aactacaaga aaaagagata cttttagtca agaatttaga cttgtatccc 42840
aatttgcaga taaaaataca gaaaaaagca tcgaatgggt cgttggggct agttttgtag 42900
atataaatga aacaaatgct aaaaaagata ctggtattta tggagatcca tcagacccat 42960
atggtcctta ttttagtaac tcttcttctt tgagtgactt ttcttcttca agctattctt 43020
tatttggaaa tattgattat ttaattaatg aaacaataaa aatttcaatt ggtggaagat 43080
gggagaattt taaatctaat tattttgatt cttatgacga atcattttca ccatcaaata 43140
aaatgtctgg tggtaagttg tcactagtta aaactcttaa taataattct aatatttatt 43200
ttaatattgc taagggctat aaccagggtg gatttaattt aggtcttggt cttgataaaa 43260
attcatcaaa tagaaattta tattatgatc cagaattttt aactaattac gaagttggaa 43320
ttaatagtaa atttttccag tcaaaattaa atcttggagc agtcctgttt tattctgatc 43380
gaaaagatca acaggtctta atttcaaccc aggttgatcc ttcagatccc aacacttttt 43440
tatacttaac ccaaaatgct gcagaaggaa ttaataatgg cttagagtta aatatagatt 43500
atgcactgaa taaatctcta ggtatatttg ctaattttgg attgctaaat acagaaataa 43560
aaaattggat ttcaagacca gatatagaag gtagagaaca ggcgcatgct ccaaaaaata 43620
gtttttcaat aggcatcaat tggaagccaa caaaccaatc ttatttatca ttgaatgttg 43680
ttggtaaaag tgagttctat tactctgatt cccataacaa tacttctgag tcatacaact 43740
taacaaacat taattatgga tatgaacatg gacaatggac ttattcatta tgggcaagaa 43800
atatttttga taagtactat tcagtaagag gtttttactt tggtaacgag gcacctgatt 43860
ttatagatac gctctacaga agacatggag atccaaggca tataggagtc atggtccaat 43920

atgatttcta actttataag tgaattttgg atggaaatag cagctgttgt atttgctatt 43980
atttatttat tacttgctgt aaaacaagac gtaaagtgtt ggtttgcggc tataattagc 44040
tcaatattat atttctttat tatgtatgac gcaggcttat atatggaagc ttacctgcaa 44100
atttttata tcatgatggc cttttatggg cttcaacagt ggagaagtgt cgatactgat 44160
gctcctcaat ttattgttag aacatgggat aaaaggatgc atattaagat cattacatta 44220
atagttatca tgactttaat ctctggattt ttattagaaa aatataccaa tgctatcttg 44280
cctttcatag atggactaac aacatgggga gcaatagttg cgacatatat ggttgccaaa 44340
agacttcttg aaaattggat atattggttt gttatagatt ttatttctat ctttttattc 44400
atgtccagag gacttttatt aacctcagga ttattcttta tttatcttgt aataatatat 44460
tttggttaca tgtcatgggt aaaaataaga gacgatatta gtgcagaatc ttcataacaa 44520
tctagatata aaaaatcata atctagagat tattaaaaca attaaatcag gccctgtatc 44580
tgaaatatct atttgtaatt ttgataacat caaagcaatc ttaagagttg atcatccatg 44640
cgcacacaaa ataaatgtag atcgagaaaa tgaaattttt atactcagcc aactaaaaat 44700
tttagatttt agtccagagg ttttatttag tgatttgtct tatggaattt tagtatggag 44760
atatatcgag ggtattgaat tttcacttgg taaggattcc aatgaagttt ttttaaaaac 44820
acttggaacc gaattaaaaa aaattcatga tattgatctc cccaaaagta agaaaaaata 44880
ttttagcaat gacataaatt tttacagaaa tttactaaag gaggttcctg aaaatataat 44940
tcttcataga ggatttgatt tatacgacaa actcaataac tctgataatt atgttctctc 45000
tcataatgac ttgaataaga caaaccttct ttggagggat aggttatttt ttttagactg 45060
ggagtactcg agttttaaca atccttttt tgatattgcc tcgttatcga atgcttataa 45120
cttatcaaaa gttgataggg caattttatg gaaagcttat acaaataatg aatattcagt 45180
attaaatgat acaaatctta gagaatggat gcatttttgt cattatttag agtacatgtg 45240
gagtatttcg ctcatacaaa atggaaaaat tgatcagaac accctaaatt taaaaaaatt 45300
agagaaaaaa ttaaaaaata ttatttaaac aacaagtatt gcgcattctt tagttgttgt 45360
tttactatta tgtaagaaat ttacatttaa atgggggttt gatatgaaaa ttttatgtgt 45420
cttatatgat gatccaaaaa caggtatgcc agaaaggtat gcaagagatg atttaccaaa 45480

gttagataag tatcctgatg gaatgacact tccatcccca aaatctatag attttactcc 45540
tggtgagtta cttggttgtg tatctggaga actagggctt cgaaagtttc ttgaagatgc 45600
tggccataca ctagttgtta cttctgataa ggatggagat ggatgtgagg ctgataaaga 45660
attagtagat gctgatattg ttatatcaca acctttcttc ccatattatt taacaagaga 45720
caagatgaaa acagcgccta atttaaaaat ggcaattaca gctggcattg ggtctgatca 45780
tgttgatctt caggcagcca tggataatag cgtggatgtt gttgaagtta cttactgtaa 45840
ttctcgttca gtcgccgaac acattgtgat gatgatccta tcgatggttc gtgattatca 45900
tacccaacat agaattgtaa aagagggagg atggaatata gctgatgctg tacaaaggtc 45960
atatgatgta gagggcatgc atgttggtac tgtagctgca ggtagaattg gtattgatat 46020
gctaagaaaa atgaaaccct ttgatgtgca tttgcattac tttgatattc ataaactctc 46080
tgatgaaata gaagcagaac taaacctcac ctatcatgat tctgtagagt cattagttgc 46140
tgtgtgtgat gtagttaata ttagttgccc attgcatcct aaaactgagc acttattcga 46200
tgatgaaatg attagtaaaa tgaaaagagg tgcatatatc atcaatactg ctcgtggcaa 46260
gatttgtgat aaagatgcta ttgcaagagg cttagagtca ggccagctaa gtggttatgc 46320
tggtgatgtt tggttcccac aaccagctcc aaatgatcac gtatggagaa caatgcctaa 46380
ccacggcatg actcctcata cttcaggtac ttcgctatct gctcaaacaa gatatgccgc 46440
tggggttaga gaaattctag aatgttattt tgcaggcgaa ccaattagag acccatattt 46500
gattgttcaa aatggtgatc ttgcaggtat gggtgcgcac tcgtacacaa agggtacagc 46560
cacagatggc tcagaagagg ccgctaagta taaaaaataa gttttagaac ttacttagcc 46620
tttccttaat aatagagtct gcctctgcca taatgctatg cattaattct tccactgtcg 46680
ggatgtcatt aaccagtcca gcaaccattc cacatgacca ggctccaacc tccatagttc 46740
cttcatgcat aatttttgga tagactcctg caacctcatc cacaatatca gcaaaagtta 46800
attcatcacc aagagctttt tctttttcaa tcaatctctc aacagcttca ttattaagaa 46860
ccctttctgt atttgttaat gatctcatga tgagtctagt atctaactca gaagcattta 46920
cgatagcctc tttcacattt tgatgaacag gtgcatcttg agtagcaata aacctagttc 46980
ccatattcat tccctcagca cctagtgaca tggcagcaac caaacttctt ccatctgcca 47040

ttccacccga ggcaacaaat ggtatttcaa gctcatctgc tgctctaggt aagagtatga 47100
aattaggaat gtcatcttct cctgggtgtc cgccacactc aaaaccatct acagaaaccg 47160
catcgcaacc tattgcttgt gcttttaatg agtgccttac agaggtgcat ttatgaataa 47220
cttttattcc tgcttctttt aaagctggga ggtattctgc aggatttctt ccagcagtct 47280
ctacaacagg aacccctgca tcaataatta cttttatcaa accaggatag tctgggggtg 47340
ttagtgatgg taaaaatgtt aaattaacag caaatggctt attggtcatt tctttgcatc 47400
tggcaatttc atttgctaat ttctcaggcg tacctgtgt tagaccagta attgttccaa 47460
gtccacccgc atttgatact gccgctgcaa gctcggcaaa accaacatgg tgcattccac 47520
cttgaatgat tggatgttct ataccaaata attcagttat tttagttttc ataatactct 47580
cctatttatc ttccattggg gttaaaaaat cttcatattg agtttgaagt ctttgcatgc 47640
cacttatcca tctatctctg tcattacctt ttcttttaac atattctaga acctcactat 47700
gaggggttac taaaaacctc tcctcctcta tggcgttaag aacatccttt gcaacaatat 47760
cagcttccat cattccatca actcctgcta caccaggacc atttgcagtc atagcagttc 47820
taactgcttg agggcataaa caggaaacgc cgatacctt atttccatat gtaattttta 47880
tccattcagc aaaactcaca gctgcagctt ttgtaactgc atatccagcc gcacctagtt 47940
gagttaaaag accggctgct gaggatgtat tcataagata gccttcacct tgttctatca 48000
tttgaggaag cacatgtttt gcagcatgaa tatgagactg aacatttaca ccccatatca 48060
tgtcccaatc cgaagtatct gcttcaaaaa atcctggctt tccaccgata cctgcatttg 48120
aacaaaatat atcaatacca ccagaaaatt cattagcctt ttgtataaca tttataatgt 48180
cgttttcttt ggaaacatca gcacttactg caagcccatt aacactcttg gctgtttcct 48240
ccgccccatt taaattcata tcaacacata ctatagaact tgccccagat gcatagaact 48300
cttcacataa agccttacca attccactgg cagcccctgt aaccacaact cttttattat 48360
taattttcat aaattgacca ctttttaat tttttattta actttattgc ttagatagtt 48420
tattacaaaa caacaatact taatattgca aaatcgcata cccatcttta taaatttatt 48480
gctattatta gtgctagaaa atgaaatact gagatttaat atgaagaatg ttgttgttat 48540
tggctcgtcc ggggcaatag gaaaagcctt tattgatagc tatatcaaag atgatgatgt 48600

tgaaaatata ttttcatttt caagaacagg cctttccatt gaggataaaa aactccatag 48660
ttttttttatt gatattgagg atgaaactag tatttgtgat gccgcagaga agatagacaa 48720
gtcctcaata gatgaaatta tcgtcgcaag tggaatactt cataataaag attttgggcc 48780
agaaaaaagt attagagatt taaatgcaga taacctttta aaggtcatta aggttaatac 48840
tatcggccca acaattgttg gaaagtattt cattccattg ctaaataaaa aagaaaaaag 48900
cgtcttagca tttttaagtg caagagtcgg cagcatttct gataataaaa caggtggttg 48960
gtatgcctat agagcgagta aaactgcact taatcaaatc attaaaagtt ttagtattga 49020
attacgaaga accaatccaa atgccattat ttttggtcta cagccaggaa cagtagatag 49080
tgaattaagc gaacctttta aaagaaatgt aaaagaaggt aatttattta ctccagaata 49140
tagtgtattg cagctaaaaa atattattga tacagcaagt ccatctgatt caggcaaact 49200
aatttcttgg gatggggaag agattcagcc atagttggtt atgaatatat tttcatatta 49260
gaataaattt ttaggggaaa aaatgagtat taaatattat gactggtcta aatttcaggc 49320
caacactagg ccaaataaag ttgccataag agagctagat aataacaaga tctatactta 49380
cggagaattg gataaaagat catcaaggct tgcatcacat ctccaaagtt caggaataaa 49440
aaaaggagat cgtattgcga tactatcgct aaattgttca gaatttttg agctagaatt 49500
tgcttgcgga aagattgggg caatagagat accattaaat tggagattaa caaaacccga 49560
gctcagttat attcttaatg atagtgagcc aaaaactcta atttatgaca atcagtttga 49620
agaaatggtg aaagagctaa aagaagaatg taatatttct gaaatcatag ctcttgatca 49680
atttgaccaa gaaagtgatt atgaaaaagt tttgagtaat gcttcaggca tttattatca 49740
ggaagaagtt gatctagaag ataacattat gattatgtat acctctggaa caaccggtca 49800
ccctaagggc gccatgatca cgcacaaaat gcagcttttt aatgttatta atttaggtat 49860
ttcagcagct gtttcccctg aatcagtcca tttagttgtc cttcctttat ttcatacagg 49920
cggaatgaat tgttattcaa atccaattct tcatgcaggt ggcgagttaa tattacttaa 49980
agagtttgag cctgggaaag ttctatcaat tatcggcagc tctgactatg gagttactca 50040
tctgtttgca gttccagccc cttatcaatt tatgatgaat catccagatt ttgaatcaac 50100
aaatttatca ggagttaagt atgctggagt tgggggcgca ccttgtgcag aggctatttt 50160

gaagacttat ataagcaagg gtgtttcgat gcagcaagga tggggtatga cagaaactag 50220

tccaggtgct actggtcttg aatcgtccga ggctgaaaga aaaataggat ctgctggaaa 50280

accgcttctt catactgagg tcaaggtggt tggagatgat gggaatgaac tgcctgctgg 50340

agaagtaggc gagatttata ttaaaggccc aaatattaca cctggctatt ggaagaaaga 50400

agaggctact agagattctt ttgaagacgg gtggttaaaa acaggtgatg ctgcttactt 50460

tgatgacgag ggtttttttat acatagttga tcgatggaag gatatgtata tctcaggtgg 50520

agaaaatgtt tatccagctg aagttsaaaa tgttatctat cagttaccac aaatcgcaga 50580

agttggagtt attggtattg atagccctaa gtggggtgag actggtaaag cctttgttgc 50640

tttaaagccc gatcatgaat tgacggcaga agaagtcata gatcattgtt taaaaaatct 50700

agcaaagtac aaaattccag agaaagttga gtttattgca gctcttccaa gaaatgctac 50760

aggtaaagtt ttaaaaagaa cattaagaga tatgtaatat ttttaagcca aaaaaaaccc 50820

agcctaagct gggtttttta tttaactatt taaagttatc taatgttaag cattagaaga 50880

ttctttaaca gcaacattcc atataattaa accaaataga atcttgttaa caaagtcagc 50940

aaggttatag ataaggttta agttaagagc tgatccaccg tcacccatca ggtaacctgt 51000

gaaataacct acaggataaa tcgcccaacc aaagatgata atatacatca ttgtgttgta 51060

agctgattgc acagcaggac ttgcagtatt acatgcagat tttccttctc cagcccataa 51120

ttcataaatc atgtataccc aagctaaaca cccaataatg aatgcaggcc atgcagccat 51180

gattcctgct tcacccatgt aaccaaacac aagcataaca agagaaccaa ctagtaattt 51240

cttaaataat gatccagcaa cattagttgc agcagcaaga attaagtaga attcacatat 51300

taatagagga actgttagta accaatcaat gtatctaaat acagttggcg aatcaccagt 51360

ttcaatccat acccctctca tgtacatgta atgccagaaa gcaataccag taacaagacc 51420

agatacagtt aatgatgttt tccattttgc agaaactcta tctctttcaa caaagaaaaa 51480

tacagtagat gctaataaag cagcagtaac taaccaaaaa gaaacaccag tgtaatcact 51540

agcatcaagg tcaccaccac ctgcagcaaa tgtaggaagt gcaataacac tacctaatat 51600

cagtaataat ttcatatata actcctatat taatgacaaa gaagcataat tgcctccccc 51660

ctaattaaat atgaaattta atagtaacca atattaatag aggttacaaa taaaaagcat 51720

ctatttttt aatagaaaat atgtgtaata aaacaccata ctttaaatta atatttattt 51780

tgcataagta gacttgttta gtatcatatt taacatgaaa gttgcaattt atcctggttc 51840

ctttgacccc atcacaaatg gtcacacgga tattattgat aggggttgcg gactctttga 51900

caaggttgtt gttgcaatag ctaagagtga atcgaaaaac cctcttttta gcctagagga 51960

tagaattaat ttagcccaat ctatttttaa aggaaatgaa aaagtagagg ttgttggttt 52020

tccaagaaag ttaacagttg atcttgcaaa agactatgga gcttgtgcaa ttataagagg 52080

cctacgagca gtttctgatt ttgaatatga atttcagtta gcaacaatga ataggtcgct 52140

ggctcccaat attgaaagca ttttttaac accaaaagaa agtctcattt atgtatcttc 52200

tagcttaatt aaagaaatat cagacttaaa aggcgatata tcgaagtttg ttcatcctat 52260

agtagagcag gcacttcgag cgagtagaca cttagctctg acaagcttca caaaaaaaag 52320

tagctctttg attgacgatc gttttacaaa tagtgccttt gcatttattg cagggctcgc 52380

cttctcttcc atatacattt aatttaaatt taaaatatcc tggactacca tcagctgagt 52440

agaagtcttt taatgtagtt cctccaacct ctattgcttg ctctagtatc ttttttccag 52500

cagctactaa tcttttacaa gcatctaaat ctaactcatt ggcatttttt agcggatgaa 52560

ttttagctaa gaaaaggctt tcagacgcat aaatattgcc gataccgact acatttttt 52620

gattcattaa atagctttta atatttgttt tagagtgact gcatcctgaa aaaaaatcct 52680

ttgcattaaa atttttagaa agaggttcag gcccaaggtt ttttattaac ttatgtttat 52740

cgatatcaga agtaagatgc attgatccaa accttctggg atcattataa ataattcttt 52800

cctcatcaaa aattaattca atatgatcat gtttgataaa gaagttttca ttatttttg 52860

caattctaag actcccagac attcctaaat gaagaataat ttttttatca ttagatagtt 52920

taaaaattat atattttgct cttctttcta agctttcgac aacttgatct tttactgagg 52980

tttcaaagct atccaccact ttccatctaa ggtttctgtt gtgtatcctt gcttctttca 53040

gcaaagagcc tttaaatttt ttaattgctc tcagggttgt ttcaacctct ggaagttcag 53100

gcatttttaa ctgagtaaat tattaatttt tactatgtca gctggagtaa ttgttcccga 53160

tgcgagccct agtcttagat tggcaagtat gtaatcatat tttgcattag caagattttt 53220

ttccgcgctg tataagtttt tttctgcctg caagagatca acaacgtttc ttgttccaac 53280

tctgtagcca acttgagtcg cttccagggc actagtggcc gaaatcactg cttgtttttg 53340
agcatttaca tttgcaacta atgttaaaac atttgaaaac tgggatctga cttcttgaat 53400
aatccttctt tctgtaaata gagtattttc atttgctctt tcatactgtg aatatgcttg 53460
cttccttctt gagttaacgg cgccgccttg aaagagtggc atacttagct gaattgcata 53520
attccttctt cctgttactg atggaactgg aataccttgg ccattgatat taaaaccttc 53580
atagttaaat tggtttgttt cagattctga ctgacttcca acaatgtcta tcttaggtaa 53640
atgatttgaa gctacacttc ttgcactgct tttcgctgct ttctttctca aatatgctgc 53700
ttttaactgg tagttatttt ccaatgctaa ttcaacccat gtctcttttg aacttggtgt 53760
tggcaggtca ataagcaaac catctcccaa ttcatttaag ctgaatattt ctctaccaat 53820
cagagcattt aaagactctc ttgcagaata aagtgatcct tctgttctaa ttcttgaggc 53880
tttacttaga tcaaatgcca attgagcctc ttgaactcca gttatggctg ataacccaac 53940
atcgaatctt tgttttgctt gatcaagttg ttttttaata gctttttctt cagatattgc 54000
tgcatttaga ttatcaatag ctctaagtac gccaaaataa agctcagcag ttcttactaa 54060
aagattttgc tgctcaaatg caaagtctgc ttcagcagca tctgtaagag atttagattg 54120
cctatattga aaccatgtat ctagtctaaa gagcggctga gtaaccctgg cagatgtaga 54180
aaaagagtta tattgctgct gcagttcttt gttttgatag tattcgttcc agttagttga 54240
tccactcaag gtaatactcg ggagaagcgc agctcttcct tgaaccttaa gctctttatc 54300
tgctaaatat gaatattccg ctgctttata tgtagggtca ttctcaagcg cttcattata 54360
gatatccaaa agactttcag atgaaatatt aaatgagata aaaagtgcta aaaatgattt 54420
tgtgtaaatt ttcataactt attttaacct attaataatg tttgcagtgc aaacatttat 54480
ttttttaat tttattgaat ttatttata tttcttagag tagaatatct ctaacaagtt 54540
caataatttt ttataataaa aaggctttaa aaattggcta aaaattcata tgacgctcag 54600
gcaattgaag tcttatctgg actagatcct gtcaaaaaaa gacctgggat gtatacggat 54660
acatctaacc caaatcattt aattcaagaa gttcttgata attcggttga tgaagctctt 54720
tcaggttatt gttcaaacat aaaagtatct gttctaaaag atggctttat taaggtctct 54780
gatgatggaa ggggtatgcc aattgatgag cacccggaac ataaagtttc aggtgttgag 54840

ctcatccttt gtaaacttca tgctggagcg aaattctctg gagatgatta taatttctct 54900
ggtggccttc atggtgttgg agtttctgtt gtaaatgccc tatctgatga attagaggtt 54960
agagtaaaaa gagattctaa agaataccaa atcactttta ataatggaga taagtcttct 55020
gaattaaagc caattgggga agtggggctc agaaattctg ggacatcaat taaattcaaa 55080
ccaaatccta catattttga aactatagag attcagataa aacagcttaa gcatttatta 55140
aaggccaaag cagttctctg tcctggatta acgatagagt tcgttaatga aaaaaagact 55200
gatgataaac aaaagtggta ttttgaagat gggctcaaaa gctatttgat tgattcttcc 55260
gagggagcag acttggtttt gctagattca attgtatgct ctaaaaaatc tcaagctcaa 55320
gagcttgaat ttgcaatcaa ttggtcatta agacccccaa aaaataaact cgatgaaacc 55380
tatgtgaatc tcataccaac tgctcagggt ggctcacatt taaatggctt taaggctggg 55440
cttttagatt cattaaaaga attttgtgaa tacagaaatc tattgcctaa aggtttaaaa 55500
attaatgcag atgatgttct taataatgca atttttataa tttcatctaa gcttcagaat 55560
cctcaatttg cagggcaaac caaggaaaga ctagattcaa aagatcacat gtcgttcgtc 55620
tcaagtacca caaaagacat tttaagtatt tggcttaaca ctcatacaga agagggcgaa 55680
agaatagcag aacttgcaat tatgtctgct cagacgagag caaaagtttc caatatagtt 55740
gaaagaaaga aaacttttag aggcccagcc ttacctggaa aactttcgga ctgtaatagt 55800
caggacttaa atgaaacaga gctttttta gttgaggggg actcagccgg agggtccgca 55860
aaacaagcaa gagaaagatc tttccaggca atcatgcctt tgagagggaa gattttaaat 55920
acttgggact tagaaagtgc agaaataata aaatctcagg agataaaaaa cctatcaact 55980
gcaattgggg ttctgccagg aaataatgac ctttcatcac taagatacgg aaaaatttgt 56040
attcttgcag atgctgattc agatggtctg catattgcaa ctttactttg tgcattgttt 56100
ctaaggcatt ataaatcttt agttcaagag ggaaggatat atatttcaat gcctcctcta 56160
tatagaatcg attctggtaa agatgttcta tatgcacttg atgataaaca gcgagatgaa 56220
atagttactg aatttaaaaa gaagaagggc aagcctaaag taaacattca aaggtttaaa 56280
ggacttggtg aaatgaatcc acctcaacta agagagactg tgatggaccc tgctactcgt 56340
cagcttgttc agctttctat cagctcaagc gataatgcaa attctatgat ggacttactt 56400

ttgtccaaaa agaacgcacc agcaagaaaa gaatggcttg aaaagaaagg gtctctagca 56460

aaaatataaa tatgaaagaa caaataacct caattagcct caagcaatat gctgaagagt 56520

cttatcttaa ctatgcaatg tatgtcattt tagatagagc tttgcctaat attggagatg 56580

gccttaagcc tgttcaaaga agaatactct atgcaatgtc agagcttggg cttgatgctg 56640

gctcaaagta caaaaaatca gcaagaactg ttggagatgt tataggaaaa tttcatcccc 56700

atggagacgg cgctgcatat gaagctatgg ttttaatggc tcaaaatttc tcattcaaat 56760

acccttttgt agatggtcaa ggtaactggg gttctcagga tgatccaaaa tcttttgctg 56820

caatgaggta tacagaatct aagttaacta aatttgcaaa tcttttaatc tctgaattga 56880

agtctggaac agtcgattgg cagcctaatt ttgatggctc tcttttagag ccagtaattt 56940

ttccagccaa actcccatct attttattga atggcacttc tggaattgct gtaggaatgg 57000

caacagatat tccatctcat aatattaatg aaattattga tgccacagta catcttattg 57060

ataatccaaa atcacagttg gttgatttac tcaagataat taatggtcct gatttctcaa 57120

ataattcgcc aataattgct agcaaagatg agctgaatga aatttattcg actggaaaag 57180

gcggcttcaa agctcaagcc caatgggcgc aggataagaa tcaaatcatt atcaacgcat 57240

taccttatca agcatctggg tctaaaattt tagagcaaat agctgatcaa atgcttaaga 57300

aaaaaattcc aatggtggtt gatcttactg atgaaggaga ccacaaggag ccagtaaggc 57360

ttgtcataac tttaaaatcg aacagagtaa atgctgaaga tgtaatgaat caccttttg 57420

catcaactga tttacaaaaa aattatagag taaatatgaa tttgatttca ttgaaaggtg 57480

gaccaaaagt tttctcccta gttgatttat tgaaagaatg gctagtcttt agaaaagaaa 57540

ctgtaataag aaaactagaa catagactcg accaggtaaa cgataggctg catatccttg 57600

aggggttatt aattgtttat ttagatttag ataaagtaat aaagattatt agagaatcag 57660

atgagccaaa aaaagatatt attacagctt ttaaactttc tgatatccag gcaaatgcaa 57720

tccttgagat taggttaagg caactagcca agctagaaca aatcaagtta gaacaagaaa 57780

gagatacttt ggtagcagaa caaacagata ttgaaaaaat actaagctct aagacaagac 57840

ttaaaacatt aattaaaaat gagcttattg aaataaaaga tgagtttgga gaagtaagam 57900

aatctccaat aagagaagca acagaagcca aagtttttc tgaagaagaa actcttgtca 57960

ctgagcctat tacagtagtc ttgtctgcag ctggctggat cagaagtgca aaaggccatg 58020
agatagaccc cagctcactt tcctatagag gagaagatgt acttcaagat tatggaagag 58080
gaaagagcaa tcaagtttca gtttttcttg actcaaatgg gaaggcttac tcacttgcaa 58140
gtcactctct tccatctgct agaggaatgg gtgatcctat tacaggaagg gtatctgcag 58200
attctggagt aaagttcatt tcttcattga ttgggaatga tgaagataaa ttcatgatta 58260
tgaatactgc tggatatggc tatatttcag agtttaaaaa tatggtttct aataagaaat 58320
caggaaaagc atttatgaaa atccctcatg aagcagacct tcttaaagcc attaaagtaa 58380
gagacgatca tttgtatata gcagcagttt caaatattgg cagactttta atttttaaga 58440
ttgatgaatt gccaactctt ggaaagggca aagggaataa aataataaat ataccaaccg 58500
ctaaatttat agcaaaagaa gagttaatga cccatgcgca acttgtttct gaggctagct 58560
ctttaaggat tgaaagcgga aagagattcc tcactttaaa actcaaagat ctagaaaact 58620
atatttctac aagagcaaaa aggggaaata tgcttccaca aggatatagg aaggtagata 58680
aaatgattga agaggttgag ttagaagtta aagaagactg attatagatt tctcaaaaat 58740
ttttaatccc tcatcaacta gctcattttc tattattagg cttggagaaa acctaacagt 58800
agatgcattc gccttaagaa tcattaaccc attatgatgg gatttttta ttaaatcatc 58860
tatttgaatt ttgctatcct tgcttacttc cactccgacc cataaaccag cagaagttat 58920
tttttcaaaa catttgtgct tctcatttat tttattcaac aaattgataa atctaacttc 58980
tttctttaaa accttattta aaaatgattt tttagaaatg gtatctataa cttcattacc 59040
tatggcacat gcaattgggc ctcctccaaa agtcgtgcca tgagaccctg ccgacatatg 59100
ttttgaaact ttatctgaag taagaatgcc tcctagtggg aagccattag atataccttt 59160
agcaaaacaa agaatatcag gagtaatgtt aaattgctca taagcaaaga gtgttccagt 59220
cctgccaatc ccggattgaa cttcatcaat tatgacaagt gccttatgtt tttttgcaag 59280
tttctttatt tttgctataa attttttatc tgcttttgtt attccagatt gccattgaac 59340
cagttctaat ataaccgctg cagtcttatc tgaaaaaacc ttttctagat tagtaatgtc 59400
attatatgga tgatttttta tccctctagg cagaggcgca aaaccgtctg taagatgctt 59460
agctttagct aaagctatac caagcatagt tcttccatga aatgacgttg aaaatgaaat 59520

gacctcattt ttatttttat taactgttga tgagcaaaat tttcttgcta tcttaactgc 59580
agcctcaatt gattctgccc ctgaattgca aaaaaatact ttatctgcaa aagaattctt 59640
gcataacttt cttgccaaag taactgaggg ctcatttatg tagagatttg ataaatgcca 59700
aagctcctca gattgctttt taagaatttt tattagatct ttatttgaat gaccaaggtt 59760
agtgacggca atgcctgctg tgaaatcaat atatttctta ttatttaggt cccatacatg 59820
cgatccactc gctttttttа caacaaaatc tgcaggagcg taaaaaggca ccatataatt 59880
agtatattct ttaattatct ctttcataaa tatattgtat cgtggtttca gttcaaaaat 59940
taaatgacca aaaatttcta gtatctttaa aaccaaacag ctcactcatt ggctttaata 60000
gaataatatt tatatctagt atatctattg tatgcggtgg catagcattg atatttttct 60060
tttttggagc aacgctcatt ttgccttttg ctggtttaga gcttggtatt ctattcactg 60120
cattctattt aagttttaaa tggagtgata aaaaagaaaa aatatttatt tctcaagatc 60180
ttgtaactat agaaaaaggc tctaattatg ctgaatataa atgggaagag ttcaggtcat 60240
ttacctcttt ccaggtttca aaagacagaa gagatcttct taagctaagc tttaggtcta 60300
aaggcgagga tgttgaggtt ggcagctttc taaatgaaga tgataaaaat gtattaatag 60360
aagagctaac tcagatcata gatacattaa atcacgattc cttctcaaag ccagagcttt 60420
aatttctttt taacttcttt tagctttaat tcttttattt cagggatgcc atttctaaaa 60480
tttggaaatg attctccctg tattaatggc ataagatatg caattgcttt tggggtaacg 60540
tccattccat ttttagctat aaaagatttt ggtaattttt tttctaaatt agctattttt 60600
gccagtggag ctggttcaat tttccaccta tatttttag ctttacctct aactattatg 60660
ggcataacac cattcatgcc ttctactgca tactgaactg ccttggcccc aacagccata 60720
gcttgctcta ggtctgtttt ggaggcaata tgtcgtgcac ttctttgtag atagtcagaa 60780
acagcccaat gatttttag ttttaattta tcagtaatta agttggcaat gtaaggcgca 60840
actccaccaa gttgagcatg accaaatgca tctattgttg ctgattcaga aagaaatctg 60900
ttcttattat ttttcaaccc ttcggatacc acaacaacac agtagccatt ttttttaaca 60960
acacttttaa cttctgctag aaatttttt tgattgaagg ttatttcagg taataaaatt 61020
atatgaggtg catctccttt ttcttttctt gcaagagaag atgcagccgc catccagcca 61080

gcatgcctgc ccataacttc taatataaaa acttttgttg atgttgctgc cattgaccga 61140
acatctaatg aggcttctag agttgatgtt gctatatatt tagccgccga cccaaatcca 61200
ggacaacagt ctgttaatac caaatcgtta tcaacagttt ttgggatggc tatacagtta 61260
attggataat ttaatttttt acttatctgc gaaactttaa atgcagtatc agctgaatca 61320
ttaccgccat tgtaaaaaaa atatcctata ttgtgcgctt taaaaacatc aataagcctt 61380
ttgtactctc tttcgcttga ctcaagatct tttaacttaa acctacatga cccaaaagcc 61440
ccaccaggcc tatatttcaa tgactctaat gcagatattg attcttttga tgtatctatt 61500
agttcctcat tcagcgcgcc caatattcca ttcttgcctg cataaatttt accgatgtct 61560
ttatgcttct tggcctctaa aatcagagcg ccagctgtag catttataac tgcggtaacg 61620
ccgccggatt gagcataaaa cgcatttttt ttcatttttt ctccatcaaa tgtactgaaa 61680
taaaaatatg taaagtatta taactaatat gcgaatacat atcttaggga tctgtggrac 61740
ctttatgggc ggccttgcta agatacttaa agagtcaggg catgaaatat ctggatcaga 61800
tattcaattt tatcctccca tgtcagacta tcttgatagc tttgatattg aaatgatcaa 61860
gggctatgac ataaaaagca tgccagatgc tgacttgtat gtgattggta atgcactttc 61920
tagaggaaat gaatccgttg agcatatttt gtccaattct cttccgttta agtcaggccc 61980
tgaaatgctt ggagaaattt taaaaaataa aaaggtttta gctatatctg gaacacatgg 62040
taaaacaacg acttcatata tgttgactca tattatgtta gatcagggta gggatgtcgg 62100
ttttctagtt ggtggaatat caaataatat atctggctct gcatgtcttg ggtcagatgg 62160
aacttttgtg attgaggcag atgaatatga ttctgcattt tttgataaaa gatcaaaatt 62220
tattcactat tcaccaagca ctatagtcat caataatatc gaatttgatc atgctgatat 62280
ttttaataat ttagatgaca ttaaaagaca attccatcat ctaattaaaa taattccatc 62340
aaatggaaat gttgtttatt ttgctgatga taaaaatata agagatctta tcgatatggg 62400
aatttggtca aatcagatag caatcaataa taatgctcat tcaattgagg cagtttattc 62460
tgataagact ctaaaatatg aagaaagtat ttattcatta aatgagttac ctttaatagg 62520
agaacataat tttaaaaact acatttcggc tattttggcg gcaaagacag atggaattca 62580
aattcaggat tctatcaaat cattagctag ctttgatggc gtaaaaagaa gattagaata 62640

taaaggaagt tttgatggca tagaaattta tgatgatttt gctcatcatc caaccgcaat 62700
agaattttct tctaatgccc tcgtaacaca aaatccatca aaaaaaatac ttggtctcat 62760
tgagctaggc tcaaacacta tgtctggggg ttctcatggc ttgtctttgg ttgaatctgc 62820
aaaatcttta actcatgtta tctggctaga tcgcaataat gttttgtcag agaatgctag 62880
cattgaatct actaacacta ctgaagattt tatttctgca gcgatatctg ctttctcaga 62940
ttatgatatt gttattttga tgaccaataa agacagccaa aaaatattaa aacccattgt 63000
agatcacttt gaaaaataat aatttaccag tttttccttt aggaatagtc gccctcccag 63060
gtagcatcca atctcttcaa atttttgagc ctaggtatat acagatggtt aaaacatgtc 63120
tatccaagaa ccatggattt gtaattgttt ttaatgccaa taatgagtct caaggcgatt 63180
tcacttttтc taagaaggga agttttgttg aaattataga ctttaataat ttgccaaatg 63240
gccttcttgg gataactgta aaatctataa ataaggtgat aatcagtaat atatgtcaat 63300
tagaagatgg actgcatatt gctgatatta aggcacagat agatccagag gtagatgatc 63360
aagctgtttt ggcagaatat cctgagatat ctagcattct ttctcagctt gtaaagcatc 63420
ctaagattag tgacctgccc atccaggttg actttggctc tgctgattca gttgcatacc 63480
acttagcagg ccttatacct ctaagctcaa atgagaaaca aaaactatta gaagcattcg 63540
atgcagcaca gcggatgaga attctttcag actatattga aagaatatct actacataaa 63600
ttatttattt taatattatt ggcggcttat tagattttgc tctaagccaa ttgatggact 63660
taaaaaccgt agggatttct acaaaccttt tttcaatata gtatttgcct ggatagttac 63720
taagcattag cccaataata atagtgaaca aacctggcca ggtaacacca gcatcatgat 63780
tcccccaata ataagggaat aacctaaaat atttttaatc agtaaaacta aataccacaa 63840
caacgggtta ttggtcttaa atttcgagac atctttcttt ataaaatagt cacttggaat 63900
taatccagca agccacctca tactaacgag actaaataaa aaaataaata aagatattga 63960
gctcagccaa agtataagaa ctttataaga ttcaaaaaaa attatgatgg catttagggt 64020
attaaattcc ataattaccc acctttttat ttaataatga tttagtatag caatgtctaa 64080
aaataaattt aaacattaaa taaatataca ataattttgc caaaaaaagc cttaaatgat 64140
atttgcactg aaaccctcag tgataataaa gccgaaaatg ttctatcact tgatatcaaa 64200

ggtatttctt cttttgctga caacatcatt attgcaactg caaattcgaa taggcatgca 64260
aagtctttat ccgaaaagtt agttgaggag ataaaagcta ataaaattag tatcatgggt 64320
gtagagggca agacagaatc aggttggata ttagtagact gtggtgaggt tgtagtaaat 64380
attatgaaga atgacataag agagttttat gatttagaag gtctttgggg tgaaaacacc 64440
ctcatcgatt cttcgaaata aatgctatta aatatcataa gtgttggaaa ctcaccttca 64500
tcttgggagt taacaggaat agaatattac acaaagcaaa tccctaaaga agtaagtcta 64560
aattttatta acgtaaaagg gcagcaacac ccaaaaagat ctacagaaga ggtcttaaaa 64620
cttgaatcta agttaatctc gtccaaaata gattctaatg gatatattgt ttgctgggac 64680
tcaagtggcg agtcgttgaa taattttgaa tttagtaaat tttttgaaaa atccatgctg 64740
gaaaatatga agctttactt tgtaattggt ggttcatttg gcatacctcg agatattctt 64800
gataaatcta ataagataat ctcgatctca agtctcaccc tacctcacag gcttttcaag 64860
attgttctta tagagcaaat ctataggtca ttttcaattc tcaaaaatct tccctaccac 64920
aaatgattga tctgaatgag aggtttgttg aaaaaagaag ctttttcaat agattgttgc 64980
ttatatattt tttctttggg gccctgtttt tattcttgct tttcaagacc tattctttac 65040
aggtttctag ctattctgac tatgaactag cagcactaaa gaataaaaca aaagaagtgc 65100
tagttcagcc tgttcgagga gtcatctatg acaggaatgg aaatattcta gttaataatg 65160
tccctacata tgacctaata atccaaccat caaaaattaa aaacttagat gatttcatta 65220
ttaatatttc taaaataata gagctatcag attcagaaat tgaaaacatt attaaaaatt 65280
ttaaaaggag tgcaacttat aatagagagc taacaattaa aaaagatctc tcgaaagaag 65340
aaatagcaaa atttgaagta agaagctacc aatttcagaa tgcatttata gatgttaggt 65400
atagtagaga aaataaatat ccttacttat tttcacacgc actcggttat gtaggtggtg 65460
taagtaatga taaggtttta tcaattttaa aaaatcaaga tttgaagcaa tctgaaacaa 65520
cttttaagta ttcaggtggt tttattgctg gaaaaacagg attggaaaat atttatgatt 65580
cagctttaag agggtccttt ggaaaaaagt tatttgaagt tgatgcaagg ggaaggcttt 65640
taaaagagct aagttttgaa aaacctatta atggaaaaag ccttttttact catttagatt 65700
taaattcaca aaaaaaagcc tttgaacaaa tgaataatag aaggggtgct gttgttgcct 65760

tagagcttaa atctggttct atagttacct acctaagcac tccaagcttt aatgtaaatg 65820
gtctttctaa tggcatgtcg tcggtagagt tcgaaaaact gattaatgat gtagacaagc 65880
cattttttga tagggccggt caaggtcggt actctccagc ttctacaata aagccagcaa 65940
tagcattgtt tggtattaaa gaaaaaatag tagactggaa ctttacactt aaagatcctg 66000
gatttttgt attaccagag gatcagagga tttatagggg atggaagaaa ggaggtcatg 66060
gaacaattga tatgaagggt gcaatcatag aaagttctaa tacttttttc ttttctcttg 66120
cttataaggc tgatattaat aatttaatca gccatctttc tgagtttggt tttggcagga 66180
atgtttgtaa agattgtttt aatccagatt ctggattatt gcctacgcct gaatggaaaa 66240
tgaataatct taattttggc tggtttaaag gagataccgt taatttaggt gttggtcagg 66300
gctatatgag tgccactcca gttcaattag catattactc tgcatttctg gcaaaaaaag 66360
gaaatcttca agagctatca tttgtcgaga gtgacagcct aagcaatact gcttttataa 66420
ataatttaag catagataac tcagactggg atcaaattca ctcaagcatg attggagtta 66480
ttgaagatcc gagaggcact gctaaaagat taaaaccttt aaaatcatat gttgttgctg 66540
caaaatctgg aacggttgag cttgtcagca cacaaacaaa ggaagattac aaactagtaa 66600
ggcaaaatat tggtaacaga gaccatgcaa tcattgtggc ttttggtcca atgcctgatc 66660
cagagtatgc agtaagtgtt gttattgaaa atggtgaaag cggcggttct gttgcaggtc 66720
ctgttgctat tgctgtttta aatgagctta tcaataaatg aagaaaaaat tagactttaa 66780
aaactttagc atttattttg atcaatattt atttattgcg ataaccctgt tgtcggtcat 66840
gggtttattt tttttataca gcgcatcaca agaagatatc agcactgttg ctaagcaagc 66900
tgtattcgtt ggttttggtt tgctgttaat gtttgtagtt agccaacctg accctgattt 66960
ttataataca ttttctgggt tatttttttgg ggggggastt gtattgattt ttctaactat 67020
gatttttggt aaagaaataa atggagccaa aagatggctt gatttaggat tttttaccct 67080
gcaatcctct gagattatta aaatatcatt gccaattttt ttatcatcat atttatataa 67140
taagccactt ccaataagca ctaggcatac ttttattaca ttgatattaa taggttttat 67200
atttgcactt gtagctagac aacctgactt gggaaccagt ttagtagtat ttatgtcagg 67260
gggttatgta ttatttttag caggattaag ccgccgttta ttggatctgc aatagcctta 67320

ttttattat ccttacctbt tttatggaat aactttctag agccatttca acaacagaga 67380

gttttaactt atttgaaccc agacgcagac ccttatggta ctgcatggaa tataactcaa 67440

tcaaaaatag caattggatc aggcggaatt aatggaaaag gttatcagga gggctcccaa 67500

gcccatcttg atdttttacc agagacagaa acagatttta tttttgctgt tattgctgaa 67560

gagtttggtt ttattggagt ctgtattttg ttatcagtat ttdtctttat atkactcaga 67620

tgtttatatt tagcatttaa tgcaagagat agattttgca ggttaactat aggaggccta 67680

agtttagttt ttgcctctac attatttatt aatttagcaa tggttgttgg tgtagttcct 67740

gtagttggta tgcctcttcc atttatcagc aaaggcggct catctttgct atcctkttat 67800

atagcttttg ggattataat ttctatggca acacataaaa aattaatgca aagatgaaaa 67860

aaattatatt tataacttta atattcacta tttcaattac tgcggattat tcgaatcatg 67920

aagatagcca aatggtaata aatgaactcg tcacaaaaca cggttttgag gaatcttatg 67980

ttactgcaat cttaaaaaat gcaaaaaagc gtgatgagat gcttaaatct gttgctaatc 68040

ctgctgaaaa aacaaaaaca tgggatgaat atagggctat ctttataaaa acaaaaagag 68100

tttcagaagg caaaaaattt ataaaaaaaa atattaatgc tttagagagg gctgagaaag 68160

aatttggagt tcctaaagaa ataattactg ctattttagg cgtagaaact aattatggca 68220

gcaataaagg tggatacaga gttttagata gtcttactac tttaggtttt gatgacccgc 68280

gaagatctaa ttttttttaga agagaactta tagagttctt ccttttaaca agagaaaata 68340

atttagatat caaaacaaca aaaggctcat atgcgggagc catgggatat gcacaattta 68400

tttcgtcaag ctaccgagcc tatgctgtag attttgatga agatggttac gttgatttat 68460

ttaattctgt tgatgatgca attgggagta ttgcaaatta tctttatgtt catggatgga 68520

agagagaagg aaagatcgta acaaaaactt atccaaacaa tgttagaaaa ttttataaac 68580

ctcatgagtc tctaacaagg ttcatacctt taatctttaa tgaagatgga aaagatcttt 68640

tttttattgg tgatgataac tttagggcta ttgctaagta taatattagc gatgtctatg 68700

caatggcggt ttattactta tcagaagagt taaaaaaatg aaaaaattat tattcacatt 68760

actatcaact tcaatattta ttcaagcaca gagttttgtt ccagattctc ctgagttaga 68820

tctgaagagc tatatcctaa ttgagccaaa caccaatact gttattgcag aatttaattc 68880

agatttggaa atagaaccag ctagcatgac taaaattatg actagctatg ttgtggctga 68940
tcagattgca aatggtttaa tatctcttga tgacgaagta ctaattagtg aaaaagcatg 69000
gagaatgcaa gggtctaaga cctttataga agctggaaaa aaagttacgg tatctgatct 69060
tttaaaaggt attatgattc agtcaggcaa tgatgcctct gttgcaattg cagaatatgc 69120
aggcggcact gaaagaggct tcgttgactt aatgaactct tatgctgcct ctttggagat 69180
gaataatacg atctttcaga attcaacagg gcttccagat gaaaatcatt tttcatcagc 69240
aaaagattta gccaatctga cagctaacta cattaataaa tttccagaag aatatgcttt 69300
atataagcag aagcaattta cttttaacaa tattaagcaa ttaaatagaa ataagctttt 69360
atggagagac gactcagcag atggtgttaa aactggtcat acagaagctg ctggatactg 69420
tttagttggc tcagcaaaaa ggggcggtat gaggcttatt acagttgttg caggaagtaa 69480
gtcagataat gatcgttttt tatcttccca aagattactt gagtatggat ttagattttt 69540
tacaacacag aagatgttaa gtgcagaaaa agaatatcag aatattacag tttggggtgg 69600
acaagaaaag atacttggcg tgggagttct agaggatata tctattactc ttcctagaac 69660
aagtttcaaa aatgttgaaa ctgtttataa agttaataac aatatccagg ctcctatcgt 69720
agttggtcaa aaagtcggga ctctagaaat aattagtaat gatgagattg ttctagttac 69780
ggatttggtt gctttaaaaa atattgaagc taaaggtttt tttggaagaa tatggtcaaa 69840
gttcgttctt tggatattta gcttatttgg tctaacagat gaaaacacca cttaaaggcg 69900
tttttaatgg ggcttttgat actgtagata acataaaaat atcacctttt tctcgagctt 69960
atacttttc tgatagcgta tatgaagtag ttcctttctt taattcaact gcaattgctt 70020
ttgatgatca tataaaaaga ttagaatttt ctgctagtca actagcgatg gccgtagatt 70080
taaaagaagt tatatttgaa attaattctt taataacatc atctgaattt agtaatggct 70140
atgtctatta tcaagttact cgaggcgttg atccattaag gtctcatatt catgagccaa 70200
atttaaaaat agaaaccttt ggctatgcaa aggcgcactt attccaatgg aaaccattaa 70260
gagtatcagt atgtgatgat attaggtggg ggaggtgtga tattaaatca acatcattgc 70320
ttggtaatgt tatgaacatg aatgcagcaa aactagataa ttgtgatgaa gttattatgc 70380
acaaagataa tttgttgacc gagggtggcg catctaatct ttttttttgta aaaaatgatt 70440

caatctgcac cccagctcta aatggaaata tacttcccgg cataaccaga gcattactaa 70500
ttaatgaatt aaaaaattat agtatagagg tcatcgaaga taacttcagg ctagaagatt 70560
tatcaaatgc ttcttgcgcg tggctcacaa gcgcaacgaa agggctggcc cccatttctg 70620
aaattagtaa cctagaatct cacttggatt tataccatcc tcttttcaaa aagagtgaag 70680
aaatttttaa taagaagttc cttagttaga agtcagttta ataactatat tatcaagctc 70740
gtaccaaaaa tctttatcac taagaccttt atttgcaaga tcaagctcaa atacattttt 70800
ttggagctgt attaagtttt gtagtttatg atttttaata aaatgcatat attcagaagt 70860
tttatttttc caaaccccag atttaattag actatctaca ggatttttac tttgtctagc 70920
attggctgca ctgttaataa ttttaccaac tatccaaact agaagaggtg cataatgatc 70980
ttccgctgat tttattgaat ggataatttt taaagcttgc ttggtattat ttgaaataat 71040
tttatcttca agctcaaatg gcataaattc tgcagactcc acagaaggtt ttctttcttg 71100
gccatcacca tctttataag tcagtcttag aagctttact tcattctgtt gggcaactaa 71160
gtttccagag ttcatttcag atatattttg cactaaagag ggcctatctt tttcagaaat 71220
aaaagatagt tgatgcttaa gccaaatctt ttcttcaaaa gatttaagtt ttccacaatc 71280
aatgatgagg gctatctcat ccatctgttt tacccactta gttgtgaaat taagctttc 71340
attgcttgaa ttaataatta ttgcaatatt atccatatgg ttaatatttt caatttgaga 71400
tattttaatt atttggtcag gtatttttcc ttgatcatga ttaatctcaa ctattatttt 71460
tgagccaaat aaagatccag aagcattttc aataatagtc tgatctattt tatcaaaccc 71520
atctttatta ataattgttt tttctttgaa ccctttattt gataaatgtt tgagcaaaag 71580
atctttagag ttatttttta agacaacctc agatccaaaa ataaagaaga tattttgtga 71640
ctgatctaaa tatttttgag ttgtcattgc ctcacatttc aaaagcatgc acctcaaaaa 71700
ttatttgatc aattaattcc ttctgcattt cagactcaag agatttaatc atttgatctt 71760
gtgcaaatgg attaagttca ttcgatttat atctcttgta gctaacaagc tttttactta 71820
tttgtttatt tccaatcatt tttatatgta tttctaaatt aatttctcct tcaagagctc 71880
ttagagaaga gcctccatag atatcatatt tatttaaaat atagtcttgt attagaatct 71940
gattttgacg attctcagct tctttttctg tattgaagag gattgctaac ttttgctcaa 72000

aagaattagg gacactacta tcaaaccgaa aattaaatag atctttttta tctagatcta 72060
tatttagttg attaaattgg cagccagtta aagatatcaa caagcaagtg tataaaaaga 72120
aaggtcttag tttcataacc tcatagtatc tatctgaaga atatatatca aagattaatt 72180
ttaaataaca aaatttatta ttttttcttt aatataaata gtttttttaa tagccgagtt 72240
gtttattgtt gatgccacat tgtcgatagc cagtgctaaa gcttctatat ctttttgctc 72300
aaggtttttg tctatcatta ccttacctct caccttttcca tttacttgaa ctattaaatt 72360
aaattcagaa acttctaata actcctctct aagaacaggc caagaagatt caatttcttc 72420
ttgtgcaaag tcaaagtaaa aattattcca taaatgttgt gagatatgag gcgcaatagg 72480
attgagagtt ttaagaataa ttattattgc ttcattaaga caatattgat ttgagatcga 72540
cgcattacct tctttaaaag aatcaggtat aaagttaact agctccatta tcgaagcaat 72600
ggctgtatta aatgaatatc ttgtttcaaa gtcatttgta acctttttaa gagtattatg 72660
cgattttctt cggagctcta cttcttgttt cgaaggatcc ttgggctcct ctaagtcaat 72720
aaattttcta ttgctgacta agttccatat ttttttcata aatcttgagg caccttctac 72780
agatgactct gaccattcta gactttgctc agggggagct gtaaacatca tgtaaagcct 72840
tacagtgtca gcgccatact tttctatata agattgagga tctacagtat ttccttttga 72900
tttggacatt ttagccccat ctttaagaac catgccttgt gtaagaagct ttttaaaagg 72960
ctcattgcct tcaactaaat ccatatctct aagcgcctta tgaaaaaatc ttgaatatag 73020
taagtgcagt atcgcatgct caatacctcc tatatataaa tcaacaggca gccaatattt 73080
tgaattttta tcaaacattt catctgcatt gtcagatgaa gtaaatcttg cgtaatacca 73140
tgatgagtcc ataaatgtat caaaagtatc tgtctctctt tttagtcgat cagaaatatt 73200
ataaaaatct tcattttgac ttaagggaat aggtgccgag ttctttttta gctctggaag 73260
cactataggc atatcctttt catcaataac tcttggttca ccattttcat aaacaaccgg 73320
aatagggcaa ccccaatatc tttgtctgct cacaccccag tctcttaatc tgaactggat 73380
taactgctca ccaaggtttg cgtctgctaa atctttaata atttcaagag atgcctcatc 73440
agagtccatg ccatcatatt tatcagagtt tattaatttg ccttttttgta caactggaag 73500
ttcattatta ttatcaaaac taataacttg aggaatctct agattatatt tagatgcaaa 73560

ttcgaaatct ctttgatcat gagcaggaac acccatcact actccagttc cataatcaag 73620
aagtacaaaa tttccaatcc atacgggtat cttcttcttt gtaattggat gaattacatg 73680
cattccacta ttaattccaa gtttttcagc tttagccata tcagcttcag cagctttcac 73740
ttctttgcat ttgtttagaa agtcttttat cgattcatta ttttttgaca accctattga 73800
tatagagtga tttggtgata ttgctaaaaa agaaacacca aaaattgtat caggtcgtgt 73860
tgaaaatacc tttaaagaat catcggaatc ctcaatcatg tatttaattt ctgctccctg 73920
agatttccca atccaattcc tttgcattgt tttaacattt tcaggccaat ccacctcatc 73980
caaagatgtt aaaagttcct cagcgtagtc tgtaattttt ataaaccatt gatcaatttc 74040
ttttatttca acttgcgccc cagacctcca tccttttcca tctataactt gctcatttgc 74100
taaaactgtc tcatcaactg gatcccagtt cactaatgat tttttcctat aaaccaaacc 74160
tttatcataa aacttttaa atattaactg ctcccactta tagtattccg gttcacatgt 74220
tctaagctct tttgaccaat catacccaag gcccaaagat ataagttgct gtttcatatg 74280
ttcaatattt tgattcgtcc aatcttttgg gctaacttta ttagcaatcg ctgcgttttc 74340
agcaggaagc ccaaatgcat cccagcccat aggctgaaaa acattaaagt tattcattct 74400
tttatatcta gatatgacat caccgatcgt atagtttctt acatggccca tatgtaattt 74460
acctgatgga tatggaaaca ttgataggca ataaaatttt tctctaccat caggattagc 74520
tttaaatttg tcttctttta accattcatc ttgaatggtt ttctctattt gacttgggtt 74580
atattcagga ttcatttttt taggaactca ttttctaagt aattaatagt atgtttattt 74640
tctttaaagg tatcatcatg cagaatcctt tgatgaagag ggtgatttgt tttaatgccc 74700
tctataaaaa attcatctaa agcactcagc attctcttaa tagccgagct tctagaattt 74760
gcctgagtaa tgatttttgc tagaagtgaa tcatagttag ggggaactct atatcctcca 74820
taaatatgtg agtcatatct tatgccaaaa ccgccaggtg tatgcatttt tgtaattgtt 74880
cctggggatg gttgaaaatt atcaggatct tctgcattaa ttctgcattc tagtgagtgg 74940
ccatgaaaat taatatcatc ttgatttagc tcaattggca tttcaagagc aattcttagt 75000
tgtgctttta ctaaatcaaa gccagttatc atttctgtta ccggatgttc aacctgaatt 75060
cttgtattca tttctataaa atagaattga ttatcttcgt ataaaaattc aatagtgcca 75120

acccctttcgt aatttatttc ttcacataaa ttgacacaag ctattagtgt tttattaaga 75180
gcttcttgat ttatattaag tgctggagct tcctcaatta ttttttgatg tctcctctgc 75240
atactgcaat cccttgtacc taaatgtatc gcctttcctt taccatcacc aactatttga 75300
acttcaatat gtctagggtt cccaataaat ttttctagat aaatggtttc attgccgaat 75360
ccatttttag cttcctgcat tgttatttct gcatgtccaa taagatcttc ctctctttca 75420
acaactctca ttcctcttcc accgccacca gccgttgcct taatcataat tggatagccg 75480
atatctctag caatttttt aaactcatca ttatcagatg gaatctcatc tttataacct 75540
ggaacgattt gaattccaga tttttcagcc agtgtttttg ctgttatttt gtcgcccatt 75600
ttttggattg tttctgaggt tggcccaata aatttaaatc cacttttttc acacatttct 75660
gcaaaattat gatcttctgc aaggaaccca tatccaggat atatagcatt agcacttgta 75720
agttctgcag ctgagagaat ggcaggtata tttaggtagc tttgagttgg agatgcaggc 75780
ccaatacaaa cagtttcatc agagaatctt aaatgtttta gatctttatc agcttctgag 75840
taaacagata ctgtcttgat accaagctct ttacaagctc ttatagctcg aagagcaatc 75900
tcaccacgat tggcaataag aactttataa ctcattttaa ttgacagtta taatttttg 75960
tccaaattca accggacttc catcttccac gtcaatactt gaaatcttgc catcaaattc 76020
tgatttaatt tcattcatca ttttcatggc ttcaactata cagagcacat cacctacttt 76080
tatattgtct cctactttta caaatggatc tttttcggga cttgggcttc tataaaaagt 76140
tcctactatt ggagaggtaa caacatcccc tatgacagtt tgcttagcct catccaattg 76200
atgagttgtt ggtgagatag ctggctcatt tttgacaatg attggttttg aaacaaattc 76260
ttgattagag ccgttatctc ttgaaattct tactgactca tctccttgac ttacttctat 76320
ttcttttaaa tcagactctt gaagcatttc tataagtttt tttatttcc taatatccat 76380
ttatttaccc ctgtatttta atatgccctt aagcatcgcc tcttcataac ccttagcacc 76440
aataccagtt atcacttctt cagctatatc agatagatat gagacatgtc taaattcctc 76500
tcttgtatat atgtctgaaa ggtgaacctc atagaatggt atgttgacac caagaaatgc 76560
atcccttata gctatgctcg tatgagtata tgcagcagga tttattatta caaagtctat 76620
tttttcttca atagtgctat gtattgattc tattatttca tgctccgcat tactttgaaa 76680

agatattaaa ttgcattgat tttgatttgc taagactaat aaatcttgtt gaatatcttc 76740
aagtgatttg ctgccatata cttccttttc tctagttccg agaagattga ggttggggcc 76800
atttataagc aatatattca tataatagat tttaacagaa atttacagat tttttaggat 76860
tttaaagata tttttataag agttgatttt tttgcatggg atagcaaaaa cccgcttcag 76920
agcatccctg atagtatatt aaaacctccg ataagttcaa tgaagaattt atttcaatgc 76980
ttataataaa ttcatctcta agaatctcag tctcgccaaa aaattcatcc ctatatagat 77040
ctttacttga ctcaagcgtc ttaaatggga gcactttatc tttaaatttg agctctatac 77100
tatccaagta catataataa ccatctctta tttgccaagt tatatatgct gcttgttttt 77160
caacattggt tgttaaagca aatacttcat tggcttctgg gaccctattt gagttttcaa 77220
aaagatttgc tgaattcaat tcacctgcaa tcacattgga tagtagtata attattaaac 77280
ttttgatcat gaagacttaa gaataaaccc ctaagtactt aaaataaaga ttttattaaa 77340
taacacggta gttaaaaatt tatgttccag actttcgcac taaaaatttt cttttatatg 77400
cctatttggc ttttaaaaat aatttttttat agaaaaagaa cagtaataag agggcatcaa 77460
tttgatgctc aatctgctgc attattgtct ttgcttccaa agaaagattt atctgaatta 77520
ttagatggtg aaattgcaaa agctagaatt actcttgaag aagcaagaat tcaaaataaa 77580
gtttctttaa caccgtctat acaagtcaga aaagtagatc atattttacc aaagcatgat 77640
ttaattctca gagaatacaa gccgcatcaa gaggatttaa aaaaagttat tctctatttt 77700
catggaggag gttatgtcct taactcagtc aatacacatg atgatatggt ttcatatatg 77760
tcagataaaa taggagtaaa gttttattct ctagactata gactatcgcc tgagagcaaa 77820
tatcctgatt ctcttgatga tgctctagat gctttttctt ggctcatcgg ccagggatat 77880
ggaccaggtg atatttcagt ttgtggagac agcgcaggcg ctcatctagc tgcttctttg 77940
tgccattacc tagctgaaca aaataaagat ttgcctagta gccagctact aatatatcca 78000
atgtgtgatc cgtcctgttc atctgagtct tataatttat tatcttcagg atatcttcta 78060
actaaaaaaa ctatgatttg gttttgggat aagcttagaa cttccgaagt aaacaataac 78120
gattcggcct ttaatctctt aaaatttaat tttgaaaaaa ctttaccgcc aacaattatc 78180
gttacaggtg gctttgatcc tctatgcgat gatggagaaa aatatgcata tttattacat 78240

aaaggtaaac ataatgtgaa acaattacat tatccaacaa tgtttcatgg gtttgcatca 78300
atgactaaat tgaaagcagc gcagatagcc gttgaagatt ttttaaaaga atataagaaa 78360
atactatgag taaaatttta gaagtaagtg acttaagcat caatttttca acaagggatg 78420
gattgtttaa tgcagtggat aatataagtt ttgatataga aaaaaatcaa accttggcct 78480
tggttggtga gtcaggttct ggtaagtcgg taactgctat gtcaattctt cagctccttc 78540
aaaaaccaca agcatcatat tccaaagagt cttctattaa gtttaatggc gatgagataa 78600
taaatgccaa gtatgaaaag ttactttcct tgagaggaaa tattatatct atgatatttc 78660
aagagccgat gacctcacta aacccttatc acagagtagg taatcagata actgaatcaa 78720
tactacttca ctcaaaaagc tcaaaaaaag atgcaataga tgaagcaaaa aaattaatgg 78780
cacttgttga gattgatgat gttgaaagac ggttctatgc ataccctcat gagctttctg 78840
gagggcagcg acaaagagtt atgattgcta tggcccttgt taataaacct gagctattga 78900
ttgctgacga gccaacaacc gctcttgatg taactatcca agcccagata ttagatctca 78960
tgtctaagct taaaaatgaa ctaggcatgt caatactttt tattactcat gatctaggcc 79020
tcgttcaaga attttctgac aatgtttgtg ttatgaagaa tggcaagata gttgaacaag 79080
gaaatactgt tgaggtattt aacaacccct ctcacgaata tacaaaaaaa cttttagatg 79140
cagaacctca gcccaaatta gataaccctg taagtgatga gccaataatt gagatcaatg 79200
acttaaatgt ttactactca ataccttcaa ctaatttttt taaaaagaat acttttcatg 79260
ctgttaaaaa tacttccttt agtatttata aaaatactac aattggcctg gttggggaat 79320
ctggatctgg aaagtcaact ttgggtaagg ctatagcaaa cttagtttct tataagggga 79380
atattaaatt tgagggaaga gatatcaact caaattccca aaaagaaaat aaagaattga 79440
aaaaaaatgt ccaaattgtt tttcaagatc cttatgggtc attatcacca cgaatgacag 79500
tgggggagat agttggtgaa ggtttaggtg ttcactttaa gcttacaaaa aaagaaagag 79560
acgaaaggat agataaggtt ctgtcagatg tcggtatcga aatagtagct aagaataaat 79620
atccgcatga gttttctgga ggccaaaggc agagaattgc aattgctaga tctttaataa 79680
tgaatcctgc ttttatgatt cttgatgagc caacatcagc attagatagg tctattcaaa 79740
ttcaggtaat cgatttattg aaagagatac aaaatgaata tgggcttact tatctttta 79800

taagtcatga tttaaaggtt attagatcga tgtcagactt tatttttgtt atgaaaaatg 79860

gagaaatcgt agagtcagga ccttctcaca aggtctttga aagcccagag caagactata 79920

ctaaaaaatt actatcagct gctttaaagt atgcatctga ataattaaat atatymcmtm 79980

tggcaaatag aaartattca aaagagctcg ttgacggtcc taatcaagct gcttctagat 80040

caatgcttag aggagtaggt ttcacatctg aggmtttcac aaaaccattt gttgggattg 80100

cttccacagg agcaaaagta accccatgca atatgcacat aaatgcactt tcagagatcg 80160

ttgagaaatc agttgatagt tcaggaggaa agggtgttct ttttaatact attactgttt 80220

ccgatggaat ttctatgggt acacagggta tgaaatattc tcttgtttct cgagaggtaa 80280

ttgcagattc aatagaaact gttgtgggat gtcttggtta tgatggagtt attgctgtcg 80340

gtggttgtga taaaaatatg cctggatgca ttattggaat ggcaagatta aatagaccat 80400

caatatttat atatggtggt tctatcaaac ctagtaaaga aaataccgac tatgttactg 80460

tttgtgagaa aactggagag tactcaaaag gcgatcttaa agaatctgaa ttaattcatg 80520

tagaaaaaat ttccgtaaaa gggcctggat cttgtggggg aatgtatacg gcaaatacta 80580

tggcttctgc gattgaagct ctaggcatga gtcttcctgg aagcagcagt caagatgcaa 80640

tttcacacga caaagaagat gattgtttta aggctggcga agcgataatg aatttattag 80700

aaaaagatat taagccttca gatattatga ctaagaatgc ttttgagaat gctataacaa 80760

tggtaattgc tctaggaggt tcaactaatg cagttctgca tttattggcc atggcgcatt 80820

caataggggt tgatttagag ctagatgact ttacaagaat aggaaaaaaa acacccgtta 80880

tggcagatct taagcccttt ggttctcatt atatgtctga actcaatgct aatggcggta 80940

ttcagccact aatgaaaact ttgcttgaga agggattact acacggcaat tgtcttaccg 81000

ttaccggtca gacgcttgct gaaaatcttt ctggaataaa accttacgag cctgatcaag 81060

agataattaa atcatttgat aatccaatta aatcaaatag ccatcttaga attctgtatg 81120

gcaacttagc gaaagatggt gcagttgcaa aaattacggg taaagaagga acttcctttg 81180

aaggaagtgc tcgtgtattt gattcagaag aagaaggggt taaagcaatc ctatctaaat 81240

ctataaaagc tggagatgtt gttgtaatta gatatgaagg gccaaaagga ggtccaggca 81300

tgagagaaat gctaaaacca acatctgcca taatgggtca aggtcttggc gatcaggtag 81360

cttttataac agacggtcgt ttttcaggag gcactcatgg atttgttgtt gggcacatta 81420
ctccagaggc tgcagatggc ggcttaattg caataattaa agatggcgac tctatattaa 81480
ttgatgcaga ttctgataag ttaattctta atatttctga ggatgaaatt tcaaatagac 81540
taagtagatg ggtaaaccca aaaacgcctc ccaaaaaagg agtcttagca aaatttgcaa 81600
aaagtgttaa atcagctagt cttggagcgg taacagatta aatatgtatt ttaaaagaaa 81660
atttccaaat agtagactaa gaagaatgcg tctcaattca aacctcagag acttgcttgc 81720
tgaagttagg ttgtctacaa atgatctaat tcagccatta tttataaaag aaggcttgag 81780
tggaaaagag gctattgaaa gcatgcccaa tattaataga tatggacaag attcaatttt 81840
ttcagaaata gaagagctac tagagcatga tataaatacg attgccctat ttccagttat 81900
taatgattcc aagaaaaaca gcactggaga tgaggctatc aatgcatcta atttgatgtg 81960
tgaaactatc agtaacataa agaaacgatt ccctgaaata atcttaatat ctgatgttgc 82020
tctagaccca tataccgatc atgggcatga cggtatttta aaaaatgatt atgttgataa 82080
tgatgagact ttagctgttt taaggaagca atcactaaca ttagctcagg ctgggacaga 82140
cataattgca ccatcagata tgatggatgg aagaataggc tctataagag aggcattgga 82200
cgaaatggat tataaaaata caatcctact atcatatgca gcaaaatata attcaaagtt 82260
ttatggtcca tttagagatg ctgttaattc agcttcaagt ctaggcaagt cttcaaaatc 82320
cagttatcaa atgtcaccaa aaaatataaa tgaagctcta catgaagttg ctatggatat 82380
taatgaaggt gcagacatag tcatggttaa gccaggtatg ccttatctag atataatttc 82440
aaaagtaaaa gaaaccttca aagtacctac ctttgcatac caggttagtg gtgaatatag 82500
catgcttaaa ctggcgattg ataaaggatg gcttgaaagc gatgttatgt tagaatcatt 82560
aataagtttt aaaagagcgg gagctgatgc aattctaacg tacgcagcta aagaaatttc 82620
caaggagata actaacaaat gagcaatgtg atagaaattc gtgatgaaga aagctttaat 82680
agcgacgtct taaattcaga aaaacctgta ttggttgatt tttgggctga gtggtgtgga 82740
ccttgtaaac agcttgcacc aactgttgaa acagttgcag cagaaaaatc agaaacatta 82800
aaggtttgca aaatggatgt tgattcaaat agagagattg ctgctaaata tggaataagg 82860
tcaatccctt cattaattat atttaaaaac ggagagcctg caggagttga agtaggtgct 82920

ctaaccaaac aacaattaga ggactttata agtacagtag tttaactttg caaagacttc 82980

tttgcatatt gcaagaaata ggattatcat ttcgacttct aaggctgaaa gccactcaaa 83040

acaaaaaccc acctttttcaa tcataaaaac aacaactaga acggaaataa ctaaatgaac 83100

cttactgaaa ttaaaataaa accaataaat gaacttgtag atatagctac tgagcttggg 83160

cttgaggatg ttggaaggct gaaaaagcaa gagataatat ttagaatatt taagcataag 83220

gcttctgaag gtgttgatat ctatggtggc ggagttcttg agattttaaa tgatggtttt 83280

gggtttttgc gatccccaga aggctcttat tgcgctggcg aagatgatat ctatgtttca 83340

ccaagccaaa taagaaagtt tagcctcagg aagggagact cagttgctgg gaagataagg 83400

acccctaaag ataaagagcg ctattttgca ttaatccaag ttgatactat taatggtgaa 83460

gagccaagaa agactaaaaa caagattctt tttgaaaatt taactcctct ttttcccaat 83520

gaaagactaa tccttgaaca aggaacaggg tctaatgaag atctttcatc tcgaataatt 83580

gatttgattg ctccaatagg aaaaggtcag cgtggactta tcgtttctcc acccaaggct 83640

ggtaaaacct taatgcttca aagcatagct cattctatta aaagcaataa tccagaagta 83700

gagcttatag ttcttttgat tgatgaaaga cctgaagagg taacagagat gtcaagaact 83760

gtaaaaggag aggttgtagc tagtactttt gacgagccac ctactcgaca cgttcaagta 83820

gcaaatatgg ttattgaaaa agcaaaaaga cttgtagaac ataagaaaga tgtagttatc 83880

ttattagatt ctattactcg tcttggaaga gcatataact cagttcagcc tgcatcagga 83940

aagatattga gtggtggagt tgactccaat gctcttgaaa ggccaaaaag gttttttggt 84000

gctgctagaa atcttgaaga gggtggaagt ctcactattc ttgctactgc tctagttgaa 84060

acaggctcaa agatggatga agttatttat gaggaattca aaggtacggg taatatggag 84120

attcaccttg aaagaaaaat agccgaaaaa agaatatatc ctgctattaa tattagaaga 84180

tcgggaacaa gaagagaaga tttacttact gctgaagatg aattacaaag aatgtgggtc 84240

ttaaggaaaa ttttagacga tatggaagat gctcagtcaa ttcagttcct aatagataga 84300

ttgaaatctc ataaaacaaa cgatgagttc tttacttcaa tgaaaggggg taatggcaag 84360

aagactagat aaagtttttt gccatatcaa tcatcatctt atcagttggg ctttgcgata 84420

cgtgaatttc taattcttta aactcatttt gacatctatc ctttatattt tctgaagcaa 84480

caataaatat ttttttttctt aaaactgcat cgtccagatt tgttattaag aatttaagag 84540

tactaaaatt atagattaaa aaaatttcat tattatctgt aacttttggt atttgctcca 84600

gcaaatagat tacttcatag caaactatct catctagact agccttaagt ttttgttgaa 84660

gaaaaccatt tgaattttcg ccgcaaaata aaagactctt tcctagaaaa tttttctcta 84720

ttaacttaag aattccttca gatgaatggc tttgtggaaa atgagatttt atgccacttt 84780

caagaagttt attggaagtt gcgggcccaa cagacaaaaa attgtgtgga agatcatcta 84840

aatcgaaaaa agattttaaa atatcaagtc cgtacgaagc agcagcttgg ctagtaaaaa 84900

ttaagtttga atatgaatga atatttttaa ttttatcgat agcgattttt gaagggtcga 84960

ttgaattaat tttagaaaga taaatatttt taagagctat ttcttgagct tcacataaag 85020

atattaggtt tcctgataaa tttttgggcc tcgtattaat tatcattttt taaaattaaa 85080

gatttcgctc cttccaaaat aaactcatca gcaaataaca taatatctat tgcaatatct 85140

tgaaaggaag atatcttttc tttataaatt ttttcgttgc cttcataaga taatattttc 85200

cctgatattt ttatttggcc atttttatct tcacataaaa tagctattgg agacaggcaa 85260

gtaccttcca tggcagcaac aaaagatcgc tctgcactgg caagaattaa ttctttaggg 85320

tcaccaatat tttctaaaag ctcaataata tctttttttat ctgacagaca ttcaattgct 85380

atatatccct gagatgcaga aggtaacatt tcttcaattg agaattcata tgaattttgt 85440

tttaaaccaa gccttttttat agcagcctta gcaactacca gcccatcaaa cagaccatca 85500

ttgagtttct ttattctagt agctatgttg cctcttactg gaatagtttt tatatcaggt 85560

cttaagttat taatttgtgc ttttcttctt ggaccagaag taccaatagt tgaatttcta 85620

gcaaattcag aaaatgattt cccatcctta gatagaagca ggtcttctgg agattcccta 85680

ctaaaaacac ttattatttt aaactttgga tcaagctttg ctggaacatc ttttaaacta 85740

tgcactgcaa tatctgcttc atcagcctct agagaggact caagtgtaga aatgaatagg 85800

ccctttccac caatttcatg aagaggttta tctgtttggt ctccttctga tgtcatagga 85860

acaagctcaa ccttaatatt attgatctta gctaataact catctgcaac aaattttgcc 85920

tgatacattg ctagttctga ttgccttgta gctattctta ttttcatttt gtttccaata 85980

aaagagcctt cacatcgcca acactctttt ctttcaagat agtgaattcc tcaggaattt 86040

ccaaggtagt aaatttacta tactcaaggt agattttaca agatggcttt atttcattct 86100

ttcgaattat agattttaga acttttaatt catattcttc gccaaaagga ggatcaagaa 86160

gaattaaatc aaaacgagat aagtcatttt ttttaatcca actaaatgca tccttaaaaa 86220

aaactttaga tttatccttg atgccaagaa gttgaatatt ttttgctaac acagaatagt 86280

ttttttttatt aagttcaacg aacacaactt tttttgactg tctggatatt gcttcaatac 86340

caagcgcacc cgttccggca aacaaatcaa gacatattaa attttcaatc tcaaattgaa 86400

gccaattaaa aattatttct tttaatttat ttgaagttgg tcttaaggaa tccttaaatt 86460

cgaaaggtat ttttttacct tttaaataac ctccagtgat tctgatattg tttttcattt 86520

tttttgcaaa atgggtatgc ctatttatta aataaatata attamaaata catttaaact 86580

aagttataat tcatccatgm gtcctacaag ataattttag aaaagcaatg aggagctata 86640

tttactctgt cagtgtgatg tcaaatgttg acgagaataa aaagtttagt gctataacag 86700

tttcttcagt tacctctgtt tctttagatc ctcctagttt gctcgtttgt atcaataaat 86760

cagctggaat tcacaactca ataaaagaag ggtcctcttt ttgcataaac cttttaaata 86820

aaaatcaaga agatatttct aatctatgca gttcatttaa gaccgaaggt gatagattta 86880

atagtggtga ctgggattta agcggcactc cgtttttaaa aagtgcccag gctaatattt 86940

tttgtactgt tgatcaatta atttcatacc acacacatac tattgtgatt ggtcatgtca 87000

caaactctct tagcgatgag aaaattaata cactgacata tgttgatggt agctatgaat 87060

aaattttcaa aaaatgtatt ttttatttta ataatactca actcttttt tcttgcctct 87120

aacatttttg ctagccagga agagtgtgaa gaaaagccaa gtgtttttat tatctctcct 87180

caagacggtt ttatctcaga atctaataat gtaaaagtct tatttggatc aaaaaatatt 87240

gaaataaatc cagctggcaa aggtgagatt gcaaaaaata aatgttttgc aagcgggcat 87300

caccatcttt tagttaatat cgaagcattg ccagagagct ttattccttt tgacaagggt 87360

tatttacatt ttggaggagg tcaaactgaa acaattcttg atcttgatcc tggaacctat 87420

tctctccaac taattcttgg atcttatgtg cataattcaa aaatgcaggt aaataacttt 87480

aaaggtcaag gacccttttt atcagaaaaa ataacaatta cagttaatta gagattagac 87540

cagttataac tttatctaga tgttcatcta agttattagc aattatattt gcactagaaa 87600

taggaccaga attatcgtca taatcatcac caactacatt caccttctt attatcccaa 87660
caagaccatg caacatagac caaagagtta tacatttaaa ggcaatcact tcctcaggct 87720
cgtctgctag attagcaaaa ctttttctca tattatcgta tgttccattt gcagatttaa 87780
gaagatctgg gtaatcggca aagttaccaa cagctgttcc aaacatcaaa tcatatgtat 87840
gtgcattttt taaaccaaac cctatatatt tgcttgcatt agtaacaagt tttttctttg 87900
taatttttt tggattctca aaaaaaacaa gctcattaag ttttttaaag ccaacggttg 87960
caacagcggc atatacacat tcttttgttt caaaatgcct ataaggagca gtttgagaaa 88020
caccactttc ctttgcaagg gatctaatac ttagtttagt gtaaccatct ctatcacaaa 88080
gcctgcatgc gcattctata agttcttcct ttaagtttcc gtgatgatag ttattcataa 88140
tttaatttta atgttgacac tgctaacata tatcatgtta ttatgtatac accgcataca 88200
ttaagttgat tacatattaa agtcaaatac agatatatga acataacaaa aataaataac 88260
accgtcatag ctcttttatt aggcaatgcg tttctatcaa atcttgaggc tttagaagtt 88320
cttgaggtta aaatgcttga tgaatatgct gtaactagag aatttcctgg aaagctcatt 88380
ccatcagacc agtctaagct agcatttgaa atacctggaa agataaactc tattaatgtt 88440
gatatcggag atgaggtcat cttaggggat gaacttgcct cattggatga tagagaagct 88500
ttagcacaat taaatcaatc aaaggctaaa tttgatttag ctgaacaagt actagcaaga 88560
tatataaatc tcagagcaga tgggcatatt tctattcaag atcttgataa ggctgaatct 88620
gatcaaatag tagctaagtc gcagtatgat ttttatagag ttaaatttga gcaaactaag 88680
ttactagctc cttttaatgg agttattcaa aatagatttc tagatacagg atcagtaatc 88740
aatgcaggtg tccaagtttt agaaatttta ggctctagca atgttgaagc aagaatttct 88800
attccaatga actatatgaa caaggttaag attggagatg agtatgaatt tgatatcaga 88860
ggaatatcta caaaagctac gttagagaga ctggctccca tgtcaaccgg aggctccaat 88920
aataggttag caatttttag atttgatacc ttttttaatc caggatcaat agtaaagctc 88980
aaactaagca tcactgagaa agcaaaaggt acatgggttc caattaagtc actgtcccag 89040
tccgaacaag gtatttgggc catatatacc attaacgagc aacaagtagt tgttagagat 89100
cttgttgatg ttatttattt tgaagacgaa tatgcttttg tcagcggaac acttaataat 89160

ggtgatttag taattttagg cggagctcaa aaaattattg aaggaaaaat aataaaataa 89220
aatgaatgtt attaattttc taatagaaaa gcctaggata ttatttctaa ctttagcatt 89280
tatattactt tctggaattt cttctgggct ttcagttcca attcaagaaa accctgaact 89340
ggctgagaga tggggaggtg ttcgtatttt tcttcccggg gcatccccag aaagaattga 89400
aacagagata gtaaatgatc tagaaatcaa acttagagaa gttgaagaaa tcgatgagct 89460
tgaatcaatt attactcaag gtttttcaac aattgtagtt gaattaaatc aaagtgtacc 89520
tcctatactt attgaagaga cttggtccaa ggttcaagac aagctcaatc aaatagttat 89580
tcctcaaggt gcagaaatat ttcttgatag aagcagtggt ccgcctatca ctgttcagta 89640
tgctgtaacc tggaacggca gtggagatgc tccactaata atgatgtcca gactagcaag 89700
ccagctaaaa agaaaattaa gctcaatagg ctcatctcat caaactgcaa tttttggtga 89760
aacagatgaa gaaattttaa ttgaactaga ttcatcaaag ctatcttcgc ttggattatc 89820
atttcaagat atcgcaagtg ctattcaagc cctagatgca aaaaaaccta ttggtgtatc 89880
ctcaaacaac aattctgagc ttttatatag actcaaagat aatatacaga gcattcaaaa 89940
actctcagaa atacctatca aggttattaa taaatcagag atcatacagc tagatgatgt 90000
ggcatttatt tcaaaaatcc cggtttctcc tattgaagac atattcttgt ttaatggaaa 90060
tgtagttatt tctgttgctg gaaccggatc attttctcaa agagtccatg attatgtaga 90120
acgcgcaaca attgttgtag atgagatgag agaaactctg ccgactgaga tcactataga 90180
tttagtttat gacgaatctg cttacacaac taaaaaattt aatgagcttg taaaaagttt 90240
ttcattagca atatttttg ttttagcttt aagtcttttt tttcttggaa ttagatcagc 90300
aataattgtt actcttatcc tgccattttc tatttgcctg gttatgattg gttgtaggtt 90360
tataggctta cccttgcata tgacatctat cactggaatt attattgcac taggattgct 90420
tatagataat gggattattg ttgttgaaga ttataagaat agaagagcat ctggattaaa 90480
tatcaatgat tcaatttcac aaggactaaa aaacttatgg gctccattag ctgctgcaac 90540
agcaacaacc gtcttctctt ttcttcctat tgttactgga gaagggtcga gtattgaatt 90600
cgtaggcggc atggcaatga cagtcattat gtctataaca tcttcattag ttttggcgtt 90660
attaatggtt ccagttctga tgagttatat ggaaaaaatt ccgttcttta aggatgtgga 90720

tattagcaag gaagggtata gaaatgaaaa aatccttaat aaatataggg ccttttaaa 90780

ctgggcgttc ttagttccta gaagagcaat catgatatcg cttgcattgc ctgttctagg 90840

attctttctt tttaattctt tacctaaaga tttctttcct gctcaagata gagatatgtt 90900

tagagttaat atagaactgc cttctaacgc ctcatcactt actacaatgc agagagttaa 90960

ggaaattaga gaagatattc tagatagtga tttaatttca atagaaaaag attattcgtt 91020

tatcggcaga atgatgccta gagttttgat gaatgttgtt ggtggagaag aaaaacaagg 91080

atccaataat attgcgcagt ctgtattttt tgctactgat tattatgaaa tgattgaaaa 91140

ccttccagat ttatcaagaa gactggttaa aaataaccct gacattatag ttaatattga 91200

tagtttctcg tctggccccc cggtttttc agatgttagt tatgtaattt ttggagatga 91260

tccagattta ctaaaatcac ttggtgagga gctagagcta attattaaca attctcctga 91320

tgtgagtctt acgaaatctg caacttcaaa ctcaataacc aatgttgagt ttgaacttaa 91380

cagctcaaat atttcactgt ctggtcaaaa tgccaattat cttgtaaatg aaatgtttac 91440

tgcaaacaat ggaatatttg ttggcactat gttggattca aacaaagaaa taccagtcag 91500

gctgaaaggg ctgtctaata aaaacaatat tacgggaaat actagtttta taacaatgcc 91560

ctctcaaggt ggttttgagt attttgatag tttcggaaaa agctcactaa caaacaaatc 91620

gtcaacaatt actaggcttg atggccaaag aacaaatgat gttgagggct ggatttggac 91680

aggtacgctc ccgtctgcta ctgaaaaatc tattaaaaaa gatgttaaag attttgaatt 91740

aagattgcca ataggctatt cattaaaaca acttggcgag gctgaaagca ggggccaatc 91800

tcaagcctca ttatactctt cagcttttat gtatttcatt cttataatag taggcttggt 91860

tatggcgctt aattctttca gagaggctgg tctaattttg tctgttgcat tcttatcaat 91920

tggactatcc tttcttggtt tatttatagg ccagcaaaat tatggattta ttggaactat 91980

aagtgcaata gggttaattg gcttatcaat aaatgattca attattgtct tatctcacat 92040

aaaagaagag gctgagaaga aatcactaac caaagctgag cttgttgaag ttgttatcag 92100

gtctacacgt catataatca ctacctcttt gacaacactt ggtggttttc ttccacttat 92160

ttttgcaagt gtattcttca aaccgcttgc ttgggcaatg agcattggag tattaggcgc 92220

gactattaca gccttattat atattcctgc aatgtttatg ataatgagaa aggttaagta 92280

ctagaacaac tttccgagca ataatttctt cctagctttt ttacaataag tgattcatga 92340

gtataggtct cgcaagaatc acatttaatc atagagttat caatcttttt tttatgaggt 92400

cctgatatga gagatctgaa aaagaatacc gcagttatta tcaatataaa tatgaccaat 92460

ggaatcaaaa gtaatatcga ttttaataag aacatttttt agtcactaga tgctggctta 92520

ctatttctta taaaattcca agaccagcca gacttatctt cagatttttt tgattgctca 92580

tcttggtagt taatagaaat tatttttta gtatcttcaa gcaattcaat atatcccaaa 92640

gattcatatg aagcctctaa gatcttaaga gctctataat tttcactaga gttaggaata 92700

ttttcaatta cataatttgc tcttcttatt gctgctatat gcgcatcaac actaacgtaa 92760

taatcagctg ccgcaagctc atttcttgca atcatatttc ttaaatagat atttctttgt 92820

ttagcatatg tagaatattg gctatcagga aatcttgtta agaattcagt tagttctgaa 92880

aatgattcct tagctcctga gatatctcta tttgatagat cagtatctgt cattcttaca 92940

ataaagctat tatctctcgt atagctagaa aggcctttca taaaatatgc ataatcaata 93000

tttggatgcc taggatgaag tcttataaat ttttctgctg cagcatgcgc agcctcagtt 93060

tcagcattca taaattgagc ataaataagc tctacttgcg cctgttcagc atatttgcca 93120

aaaggatatc ttgattcaat tgcttctaat gaatcaatag caccaaaata atttttttcca 93180

gccatccttc tttgggcttg atcgtaataa atttttttcag gctgttctat ttctgggcca 93240

tcagaattac aactaaccaa taacagagtt acaattggca atactataaa tagttttaaa 93300

attagtttat ctttcattat ttgcacattc tacctgcatt atcgtaattt aagcttgaaa 93360

acatctattt agattaattt ttttataata agttcatatg attgttaaaa atgttccaaa 93420

tgatctatct tcaatgaggc tagacaaagc tacagcagaa atgtttacag attattccag 93480

aactcagata aaaaaatgga tagaagaagg cagagttctt ataaatggag aggtatccca 93540

gccaagagat aaagtttatg agaatgatca gattgaatta agccctaaag aagaacaaaa 93600

agtatcatgg gaagctcaag atatagattt tgaaattcac tttgaaaatg aagattttat 93660

tataattaat aaacctgctg gtttaataat gcatccaggt tctggttgct atgatggaac 93720

tctcgcaaat gggctcattt ataaatttcc agaattgatc aatattccaa ggtcgggaat 93780

tgttcatcga ttagacaaag atacttctgg cattctgctc gtagcaagaa atgagtcttt 93840

taggaacttt tttattaatg aaatgcagga gaggagagtt gtaaaaaaat atacgtctat 93900
tgttattggt tctacactag gaagcttttc tatagaagag ccaattggaa gagataaaaa 93960
taatagaacc aaaatggcaa ttcgagaaga tggcaaagat gctttaacat ttgtaaagct 94020
taaagaaaat attggaaact actctgtgtt ggatataaga atagagacag gaagaactca 94080
tcagattagg gtccatctat catcaaaaaa actaccaata attggagata aaacctatga 94140
cccaagcagg tctattgcaa gagataccc tgaagagcta attaatatta tccgaggttt 94200
tccaaggcag gcattacatg caacacacct ctcattcaat gaccaaaaaa caaataatat 94260
tttttctttt gatattccca ctccaaatga tatggaggaa ctacttctag aattaagaaa 94320
attgatctaa tagtaactaa aaacttgttt tttgattaat aaaataatat aaaccttatt 94380
cctaagagtt ttttggtaag aaattgaaat tatctggcgc agacatgcta atgcaagcac 94440
ttcatgatga aggtgttgag ctaatctttg gctacccagg tggagccgcg cttcatatct 94500
atgatgcaat ttttagacaa gataaaatag atcatatttt agtaaggcat gagcaaggtg 94560
caacccatgc agcagatgga tattcaaggg cgacaggtaa gccaggagtt gtcttagtca 94620
cttctggacc tggtgcaaca aatgctatta caggaatcgc gactgcattt atggattcca 94680
taccaatggt agttatttca gggcaggttg ctagccattt aataggtact gatgcttttc 94740
aagaaactga tatgattggt gtttcaagac caattgttaa gcatagctat acagttttta 94800
atgctgaaga aatacctaag ataattaaag aagcttttta tgtcgcaact tcaggcagac 94860
ctggacctgt tgttatagat atcccaaaag acatgacagc tccggataat ctttttgatt 94920
actcgtatcc tgaagaagcc aagataagat catacaatcc tccgattgag ccagaaaaaa 94980
atcaaataga tagagcagtc gaagctatat tgatatcaaa aaaaccagtt atatatgctg 95040
gtggtggggc aattgctagt aatgccgaaa aagaattact tgaacttaat gaaattattg 95100
atgctcctgt tacaaatact ttaatgggat tgggtattta ccctgctagt catcatagat 95160
ttcttgggat gttagggatg catggaacat atcaggcaaa tatggcaatg cataatgcag 95220
acttaataat tgctattggc gccagatttg atgacaggat taccaataaa ccatcaaagt 95280
ttgcacctaa tgccaaagtg gttcatctag atgttgatca ctcatctgta tcaaaaatta 95340
tagaagcaaa tgtagctgtt tttgggcaag taaaaaattc cttaaaatta ataaaagaaa 95400

ctcttgaaaa aaaattagac tcttacgatt ctttcgctct tcagccttgg cacgatcaga 95460

taaaagaatg gaaatcacta catggtttaa attatgagct ttataaagat gaatctgatg 95520

atcatcccat tttaccccag gctgtagtcc agcatgtcca tgagattaca aatggggaag 95580

catatgtgac ttccgatgtt ggtcagcatc aaatgtttgc tgctcaatat tatcattttg 95640

ataagcctag aagatggatc aattctggtg gtctaggaac tatgggtttt ggtttgccag 95700

cagcaatggg tgtaaaactc gcttttccaa aagatgaggt tgtttgcatt actggtgagg 95760

gtagtatcca aatgtgcatc caagaattgt ctacatgtct tcaatataat ctcccaataa 95820

aaataattaa tatcaataac gaagctcttg gtatggttaa acaatggcag gatatgaatt 95880

atggaggaag gcactctgaa agtacctatc aaaactcgtt accggatttt ataaaactgg 95940

ctgaatcata tggtcatata ggaattaaaa ttacaaaaaa ttctgattta agtgaaggct 96000

taaaaaaagc ttttgaaatg aaagataaac ttgtctttgt tgatatttat gtagatcctt 96060

cagagcatgt ttatccaatg caggttgcaa atggcagcct agaaaatatg tggctatcaa 96120

aggatgaaca aacatgatta aaagaaaact aattttaatt atggaaaata aaccaggagc 96180

tctagtaaga gtagttggac tgtttcatca aagaggctac aacattgaaa cccttcatgt 96240

agatactgtt aaagactttt ctacttacaa atcgatattg aaaaaaaact tgaaaccaaa 96300

tttgaggata atcaaatatc tagactgacc atagaaacaa tggtttcaga tgaccttatg 96360

aggcagattt tgagacagct caataaatta atagatgtta tagctgtaag caatgaagag 96420

acaacctatt taaaaggagt attattagat gaaaatttat tatgacgaag atgcaaacat 96480

agaaattatt aaagggatga atgtctcaat aattggctat ggatctcaag ggaatgctca 96540

tgcaaataat cttcatgaat ctggtgtaag tgttactgta ggtttaagag aagggtcttc 96600

ttcatgggca aaggcagaag aagcaggctt aaaagttcaa acagttgctg attcggtaat 96660

ccaagcagat ttggttatga ttttggcacc agatgaattc caaaaaaata tatatgaaac 96720

cgaaatcaag ccaaacttaa aaaccagtgc aattcttgca tttgcacatg gctttaatat 96780

tcattttgaa aaaatagttc ctgaagcaac taacagcgta attatgattg caccaaaagg 96840

tccaggccat actgttagaa gtacttatac caatggtgga ggcgttccat ctctcatagc 96900

tatatatgaa gatgctttaa gtgatgaaga ttattcagca aaagatgtag ctctatctta 96960

tgcaaaagca aatggcggca cgagggctgg tgttcttgaa acatctttta aagaagaaac 97020
agaaacagat ttatttggcg aacaagcagt tttatgtggc gggcttaccg ctttaattaa 97080
agctgggttt gaaactctag ttgaggcagg ctacagtgaa gagatggcat attttgaatg 97140
ccttcatgaa acaaaactaa tcacagactt aattcaagaa ggtggcattg ctaatatgca 97200
ttactcaata tcaaatactg ctgagtatgg tgattatgtg agtggaccca aagtaattac 97260
tagcgatacc aaaaaagcaa tgaaaggaat actagaaaat atacagtcag gaaaattcgc 97320
agatgacttc ttgaatgact gtcgacaaag caatgatggc actggcggac ctgttatgaa 97380
aagcaataga gaagctacaa aaattcatcc aatagagtcg gtaggggctg agctaaggtc 97440
taaaatgaag ttcctaaatt cacaaaaatt ggtggataaa gaaattaatt aaaattaatt 97500
aaaaaaaagg tatcttcttc ggaataactt cgttaagata cgcgtccgca caaagaggcg 97560
gttgttcttt aaaaatattt ggttactcgt gtgggtgttc aaaatacgag aaaaaataat 97620
ttagattttt tataaaaatc aacaaaacat gatattaatt gaagagtttg atcatggctc 97680
agattgaacg ctggcggtag gcttaacaca tgcaagtcgt gcgagaaagt atcttcggat 97740
atgagtagag cggcggacgg gtgagtaacg cgtaggaatc tacctagtag aaggggatag 97800
cccggggaaa cccggattaa taccgtatac ctccttcggg agaaagaagg cctctctttg 97860
aagctttcgc tactagatga gcctgcgtaa gattagcttg ttggtgaggt aaaggctcac 97920
caaggcgacg atctttagct ggtctgagag gacgatcagc cacattggga ctgagacacg 97980
gcccagactc ctacgggagg cagcagtggg gaatattgga caatgggcgc aagcctgatc 98040
cagccatacc gcgtgtgtga agaaggcctt cgggttgtaa agcactttaa gcagggagaa 98100
aaagttataa gttaatacct tataaccctg atgttacctg cagaataagc accggctaat 98160
tccgtgccag cagccgcggt aatacggaag gtgcaagcgt taatcggaat tactgggcgt 98220
aaagcgcgcg taggtggttt gttaagttgg atgtgaaagc cctgggctca acctaggaac 98280
tgcatccaaa actaactcac tagagtacga tagagggagg tagaattcat agtgtagcgg 98340
tggaatgcgt agatattatg aagaatacca gtggcgaagg cggcctcctg gatctgtact 98400
gacactgagg tgcgaaagcg tgggtagcga acaggattag ataccctggt agtccacgcc 98460
gtaaacgatg acaactagct gttgggagac tatgtctttc agtggcgcag ctaacgcttt 98520

aagttgtccg cctggggagt acggccgcaa ggctaaaact caaatgaatt gacggggacc 98580
cgcacaagcg gtggagcatg tggtttaatt cgatgcaacg cgaaaaacct tacctactct 98640
tgacatactt ggaggctctt gtaatgagag tgtgcctttt ggaaccaaga tacaggtgct 98700
gcatggctgt cgtcagctcg tgtcgtgaga tgttccgtta agtcggataa cgagcgcaac 98760
ccttaccctt atttgccagc gattcggtcg ggaactataa ggggactgcc ggtgataaac 98820
cggaggaagg tgaggacgac gtcaagtcat catggccctt acgagtaggg ctacacacgt 98880
gctacaatgg gagatacaga cggacgctaa gccgcgaggt ggtgctaatc ctaaaaagtc 98940
tttcgtagtc cggattggag tctgcaactc gactccatga agtcggaatc gctagtaatc 99000
gcggatcagc atgccgcggt gaatacgttc tcgggtcttg tacacaccgc ccgtcacacc 99060
atggaagtgg attgcaccag aagtagatag tctaacctta gggagggcgt ttaccacggt 99120
gtgcttcatg actggggtga agtcgtaaca aggtagccgt aggggaacct gtggctggat 99180
cacctcctta acgataaatc gcgttttaaa cgcccacacg agtaatcaaa tattaaaaaa 99240
aagaacattt agatatgtaa aatcattggt atgtaatttt ctagtgtata catttatgta 99300
tacataagat cactgcaatt aaaaagtaac atatgcattt atgtgtatgt taaaaaagta 99360
attaatatat tttattaagt tactctcaaa aatgaagata aaacttcaaa aaaaatatgt 99420
aacctttttt aaggttatat gatcaagtaa aggaagagca caaggcggat gccttggcag 99480
cataaggcga tgaaggacgt aataacctgc gataagcctc ggggagctgg taaataagct 99540
tcgatccgag gatttccgaa tgggaaaacc caatacacat aagtgtatta tcttatactg 99600
aatacatagg tataagaggc aaacctaggg aactgaaaca tctaagtacc tagaggaaaa 99660
gaaatcaaca gagattccgg tagtagcggc gagcgaaacc ggaccagccc ttaagcttat 99720
tttagtccag caaaatattc tggaaagttt agccatagta ggtgatagcc ctgtatgcga 99780
aagactaatt taagtgaaat cgagtaggtc gggacacgag aaatcttgac tgaacatggg 99840
gggaccatcc tccaaggcta aatactctat gctgaccgat agtgaaccag taccgtgagg 99900
gaaaggcgaa aagaaccccg gcgaggggag tgaaatagaa cctgaaacct tgtgcttaca 99960
agcagtcgga gcagacttgt tctgtgacgg cgtacctttt gtataatggg tcaacgactt 100020
aatttcagta gcaagcttaa ccatttaggg taggcgtagg gaaaccgagt cttaataggg 100080

cgctcagttg ctggaattag acccgaaacc gggtgatcta tccatggcca gtgtgaaggt 100140
cgagtaacat cgactggagg cgcgaaccca cttatgttga aaaatgaggg gatgagctgt 100200
ggataggagt gaaaggctaa tcaaacccgg agatagctgg ttctcttcga aaactattta 100260
ggtagtgcct cgtgtattac tgtagggggt agagcactgt ttcggctagg gggtcatccc 100320
gacttaccaa accgatgcaa actccgaata cctacaagta tgagcacggg agacagactg 100380
cgggtgctaa cgtccgtagt cgagagggaa acaacccaga ctgtcagcta aggtcccaaa 100440
ttatgattaa gtgggaaaca atgtgggaag gcacaaacag ctaggaggtt ggcttagaag 100500
cagccatcct ttaaagaaag cgtaatagct cactagtcga gtcggcctgc gtggaagata 100560
taacggggct aaatcataaa ccgaagctac agatcttaaa tttatttaag atggtagaag 100620
agcgttctgt aagcggttga aggtaagctg agaggcgaac tggacgtatc agaagtgcga 100680
atgttgacat gagtaacgat caaagaggtg aaaaacctct tcgccgaaaa accaagggtt 100740
cctgtccaac gctaatcgag gcagggtgag gcggccccta aggcgagggc gaaagccgta 100800
gtcgatggga aacaggttaa tattcctgta ctttttataa ctgcgatggg gtgacggaga 100860
aggttagact agcacggcga cggttgtccg tgttcaaggt tgtaggctgg tgttctaggt 100920
aaatccggaa cgctaaggct gagaactgat aacgaccact ctacgagtgg gaagtagtcg 100980
ataccatgct tccaggaaaa acctctaagc ttcaggttat aagaaaccgt accctaaacc 101040
gacacaggtg gttaggtcga gtagaccaag gtgtttgaga gaactatggt gaaggaacta 101100
ggcaaaatag caccgtaact tcgggagaag gtgcgccgcg tttggtgatg agacttgctc 101160
tctaagctga acgtggtcga agataccagg tggctgcgac tgtttactaa aaacatagca 101220
ctctgcaaac tcgtaagagg aagtataggg tgtgacgcct gcccggtgcc ggaaggttaa 101280
ttgatggggt tagcttatgc gaagctcttg atcgaagccc cggtaaacgg cggccgtaac 101340
tataacggtc ctaaggtagc gaaattcctt gtcgggtaag ttccgacctg cacgaatggc 101400
gtaacgatgg ccacactgtc tccaccatag actcagtgaa attgaaatcg ctgttaagat 101460
gcagtgtacc cgcagctaga cggaaagacc ccgtgcacct ttactatagg ttcgcactgg 101520
actttgacct tacttgtgta ggataggtgg gagactttga agcagagacg ccagtctttg 101580
tggagtcatc cttgaaatac cacccttgta agattgaagt tctaacctag gtccattatc 101640

tggatcaggg acagtgcgtg ctgggtagtt tgactggggc ggtctcctcc taaagagtaa 101700
cggaggagta cgaaggtatc cttatcacgg tcggacatcg tgaggtaagt ataaaggcag 101760
aaggatgctt gactgcgaga tcgacggatc gagcaggtag gaaactaggt cttagtgatc 101820
cggtggttct gaatggaagg gccatcgctc aacggataaa aggtacgccg gggataacag 101880
gctgataccg cccaagagtt catatcgacg gcggtgtttg gcacctcgat gtcggctcat 101940
cacatcctgg ggctggagca ggtcccaagg gtatggctgt tcgccattta agtggtacg 102000
cgagctgggt ttagaacgtc gtgagacagt tcggtcccta tctgctgtgg gcgtttggag 102060
atttgaggga agctgattct agtacgagag gaccgaattg gacgaacctc tggtgttccg 102120
gttgtcacgc cagtggcatt gccgggtagc tatgttcgga aaggataacc gctgaaagca 102180
tataagcggg aagcctctcc caagattaaa tctcccagag actttatgtc tcctaaagag 102240
tcgtcataga ctatgacgtt gataggcaag atgtgtaagc gctgcgaggc gttgagctaa 102300
cttgtactaa taactcgtga ggcttgatca tgtaacctta agcaaggttc ataatttgag 102360
taaaacattg tagtgagaat taaaaaataa aaagttacat accagtttgc ctgatgacaa 102420
tagcaacttg gaaccacctg atcccatctc gaactcagaa gtgaaacgag ttaacgccaa 102480
tggtagtgca gggtctccct gtgtgagagt aggaaatcgt caggcttttt tctttaaggc 102540
ttccagttta ctggaagcct tttttttat ctcaagtata atacccagat gattattgga 102600
ttaacaggag gcattggttc tggcaaatct gccgctgcag acttctttat tgatttaggt 102660
atatcagtct tagatgcaga tcaagttgct aaagaagctt tatctacaaa ttctcctgga 102720
tatactgatt ttatttctca atttggtgaa gtgtatttaa ataataatcg tgaggttgat 102780
aggctgaaat tgcgcgaact tatttttca aatccttcaa aaaaaaagga tcttgagaat 102840
attattcatc ccatagttcg gtctgctatt agtaatttta ttattacatc aacatcacca 102900
tattctattg ttatggtgcc actcattttt gaaacaaatt catataaaaa ttacgataag 102960
attattactg ttgactgtga tttagaactt cagatagtaa gggcctcaag tagagatgct 103020
caaaataaat cgcagattaa gaatattatt aataagcaag cctctagaga ggagaggcta 103080
agtatttctg atgacgtact tatcaataac agcaccctat ctgatctaaa aaaacaagtt 103140
aatgttttac atactaaata tatggagtta ttaaatgagt agttgcccta gatgtgaaaa 103200

acctgtcaaa ctttctactg acaatattta tagacctttc tgctctgaga aatgcaaact 103260
tatagatttt ggtgattggg ctaatgaaga taataaaatt tcaagaccaa ttcaatctga 103320
agatttttac gaagattaaa tttaagaaag tctccattca ccactttcaa tcatcggttt 103380
ggctttttta tacttcattt cttgcgtatc ttgaccgtta gtaattttta caagatcatt 103440
tctgcctaac ttaggttcgt ttcttgtcac agtacttgtt tttactatag gagtggcttg 103500
tttttcattt tgaaagatat cagaattaat ttcctctttt tccaatttta attcttgaga 103560
actatttttgt ttgtttatgc tctctagctc agattctgtc gatatttgta atgagaaaag 103620
tattcttata gtttcaacat ctatttccga aagcatagat tcaaacattg aatatgcctc 103680
tcttttgaat tcatttttttg gatttttttg agcataagcc cttagaccaa cactatttct 103740
taaatgatct atttctgata aatgctcttt ccaatggaca tcaagtactt gcagcataac 103800
ctgcttctca agaagcaatc tattttcacc aagatcacta aacttttttg aatatttatt 103860
ttttgcttgc agaacaattt cttcggcaat tgtatttggt acaagttttt tattactatt 103920
aattttattg gctatatctg tttctagtcc atagctctct tttaaataat catcgagctg 103980
cctacttttc cattgagact ctattgattc ttcaggtaca tataaattag atattccttt 104040
gaattgctgc tcgatgagtg actcaatggt actgctaata tcttcctctt ctagtaattg 104100
attccttaaa gaatatatag cttgtctttg atcatttgat acatcgtcgt actctaaaag 104160
atttttcctt gcatcaaagt ttctgctctc aattcttttt tgcgcatttt ctattcctct 104220
tgaaagcatt ttagcttcaa tatgatcatc tcccatgccc agcctttcaa aagtagccct 104280
tcttccatcc gaaataaaaa gtctcaagag atcgtcttct aaagataaga agaattttga 104340
ataacctgga tcaccttgtc tgcctgatct ccccccttaac tgattatcta ttcttcttga 104400
ttcatgcctt tctgttccaa gtatatgaag cccaccagat tctataactt ttttattatt 104460
ttctttccac tctatatcgc tttggtcttc tttttttccg ccaagaacta tatccgtccc 104520
ccttcctgcc atattcgtag caatagttac cattccaggt ttacctgcat tggcaattat 104580
ctctgcttct ttttcgtgat gcttggcatt taaaatttga tgaggtattt ttttgttatt 104640
taaatatgct gatacttctt ctgaagattc aaccgaaact gttccaacaa gaatgggaga 104700
agatttttttt cttaattgtt caatttcttc aattagagct ttatatttcg attctgttgt 104760

aagaaatact aagtcattaa gatcagctct agccatagga acatttgttg ggatgatgat 104820

gacatttagg ccatagattt gactaaactc tactgcttca gtatctgctg ttcctgtcat 104880

cccagaaagt tttttaaata atctaaaaaa gttttggaat gtggtggatg ctagtgtttg 104940

agactctctt tggatagcaa cattttcttt gcattccagt gcctggtgaa caccttcact 105000

cattcttctt ccgggcattg ttctacctgt atgctcatca atcaaaagaa cctcaccgtt 105060

cctaaccaaa taatccacat tctttttaaa taagaagctt gctctaagtg ttgcttgaac 105120

aaatttcata atttttaaat tagaaacaga gtaagcccat ctgaggctcc aagccgattc 105180

cagc 105184

<210> 2
<211> 29
<212> DNA
<213> pcr primer

<220>
<221> oligo-nucleotide-primer
<222> (1)..(29)

<300>
<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A., Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L., Spudich,E.N. and DeLong,E.F.
<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea
<303> Science
<304> 289
<305> 5486
<306> 1902-1906
<307> 2000-09-15
<309> ____-__-__

<400> 2
accatgggta aattattact gatattagg 29

<210> 3
<211> 24
<212> DNA
<213> pcr primer

<220>
<221> oligo-nucleotide-primer
<222> (1)..(24)

<300>
<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A., Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L., Spudich,E.N. and DeLong,E.F.
<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea
<303> Science
<304> 289
<305> 5486
<306> 1902-1906
<307> 2000-09-15
<309> ____-__-__

<400> 3
agcattagaa gattctttaa cagc 24

<210> 4
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> light-driven proton pump; has the properties of a light-driven pr oton pump when expressed with retinal in Escherichia coli. Note that additional three nucleotide residues incorporated by pcr priming with reference to the original 31A08 DNA sequence (DNA residues 4-6, ggt), adding a new restriction site for cloning

<300>
<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A.,Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A.,Spudich,J.L., Spudich,E.N. and DeLong,E.F
<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea
<303> Science
<304> 289
<305> 5486
<306> 1902-1906
<307> 2000-09-15
<308> AAG10475
<309> 2000-06-15
<313> (1)..(750)

<400> 4
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

```
ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220
```

```
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 5
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 5

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140
```

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 6
<211> 747
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(747)
<223> Native proteorhodpsion DNA sequence from BAC clone 31A08

<300>
<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A., Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L., Spudich,E.N. and DeLong,E.F.
<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea
<303> Science
<304> 289
<305> 5486
<306> 1902-1906
<307> 2000-09-15
<309> ____-__-__

<313> (1)..(747)

<400> 6

```
atg aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca ttt       48
Met Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr Phe
1               5                  10                  15

gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt tct       96
Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val Ser
            20                  25                  30

ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc ttt      144
Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe Phe
        35                  40                  45

gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act gta      192
Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr Val
    50                  55                  60

tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg aga      240
Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met Arg
65                  70                  75                  80

ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac att      288
Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr Ile
                85                  90                  95

gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta att      336
Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu Ile
            100                 105                 110

ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta cta      384
Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu Leu
        115                 120                 125

gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca gga      432
Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala Gly
    130                 135                 140

atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg gta      480
Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp Val
145                 150                 155                 160

tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt aat      528
Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys Asn
                165                 170                 175

act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat att      576
Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr Ile
            180                 185                 190

atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt tac      624
```

```
Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly Tyr
        195                 200                 205

ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat aac      672
Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr Asn
    210                 215                 220

ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg aat      720
Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp Asn
225                 230                 235                 240

gtt gct gtt aaa gaa tct tct aat gct                                  747
Val Ala Val Lys Glu Ser Ser Asn Ala
                245
```

<210> 7
<211> 249
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 7

```
Met Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr Phe
1               5                   10                  15

Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val Ser
            20                  25                  30

Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe Phe
        35                  40                  45

Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr Val
    50                  55                  60

Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met Arg
65                  70                  75                  80

Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr Ile
                85                  90                  95

Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu Ile
            100                 105                 110

Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu Leu
```

115 120 125

Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala Gly
130 135 140

Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp Val
145 150 155 160

Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys Asn
165 170 175

Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr Ile
180 185 190

Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly Tyr
195 200 205

Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr Asn
210 215 220

Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp Asn
225 230 235 240

Val Ala Val Lys Glu Ser Ser Asn Ala
245

<210> 8
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> proteorhodopsin variant from clone EBAC40

<400> 8
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96

```
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

gac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
```

Asp Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

aat gtt gct gtt aaa gaa tct tct aat gct 750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 9
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 9

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp

145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asp Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 10
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> proteorhodpsin variant from clone EBAC41

<400> 10
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gct act gct gct tta tta gca tct act gta ttt ttc 144
Ser Phe Trp Leu Ala Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act 192

```
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gct act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gat ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 11
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 11

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Ala Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr

180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 12
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from clone EBAC64

<400> 12
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc 144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act 192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg 240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

aga gga gta tgg att gaa act ggt gat tcg cct act gta ttt aga tac 288

```
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct ata ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Ile Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 13
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 13

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
```

1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
180 185 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Ile Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr

210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 14
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone HOT01m: GenBank# AF349978

<400> 14
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc 144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act 192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg 240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

aga ggg gta tgg att gag acc ggt gat tcg cca act gta ttt aga tac 288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta 336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

```
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 15
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 15

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30
```

```
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240
```

```
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250


<210>  16
<211>  753
<212>  DNA
<213>  Naturally occurring gamma prtoeobacterium

<220>
<221>  CDS
<222>  (1)..(753)
<223>  Proteorhodopsin variant from pcr clone HOT75m1: GenBank#AF349979


<400>  16
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt gct      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Ala
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140
```

```
gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gcc gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 17
<211> 251
<212> PRT
<213> Naturally occurring gamma prtoeobacterium

<400> 17

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Ala
    50                  55                  60
```

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 18
<211> 753
<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone HOT75m3; GenBank#AF349980

<400> 18

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
```

```
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg aag      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 19
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 19

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95
```

```
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 20
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone HOT75m4; GenBank #AF349981

<400> 20

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca        48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt        96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt       144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act       192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg       240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat       288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta       336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt       384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct       432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg       480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta       528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg       576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt       624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
```

```
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250


<210>  21
<211>  251
<212>  PRT
<213>  Naturally occurring gamma proteobacterium

<400>  21

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125
```

```
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 22
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone HOT75m8: GenBank#AF349982

<400> 22

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
```

```
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga ttg gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gcc gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
```

```
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                     753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
            245                 250
```

<210> 23
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 23

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
```

145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 24
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB0m1: GenBank#AF349983

<400> 24
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc 144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act 192

```
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 25
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 25

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala

```
            180                 185                 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 26
<211> 750
<212> DNA
<213> Naturally ocurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB0m2

<400> 26

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
```

```
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gct act aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gag ctt tgg ctt gga gaa gga aaa gct gcg tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Leu Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat aca gca agt cct gct gtt cag tca gct tac aac aca atg atg atg      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Met
            180                 185                 190

atc atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gca ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 27
<211> 250
<212> PRT
<213> Naturally ocurring gamma proteobacterium

<400> 27

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
```

1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Leu Gly Glu Gly Lys Ala Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Met
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr

210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 28
<211> 750
<212> DNA
<213> Naturally occuring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB20m2; GenBank #AF349985

<400> 28
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc 144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act 192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg 240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac 288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta 336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

```
att ctt gct gct gca act aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 29
<211> 250
<212> PRT
<213> Naturally occuring gamma proteobacterium

<400> 29

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30
```

```
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240
```

```
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250


<210>  30
<211>  750
<212>  DNA
<213>  Naturally occurring gamma proteobacterium

<220>
<221>  CDS
<222>  (1)..(750)
<223>  Proteorhodopsin variant from pcr clone MB20m5; GenBank#AF349986


<400>  30
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gct act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140
```

```
caa att atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gln Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt ggg tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ctt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Leu Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 31
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 31

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60
```

```
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gln Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Leu Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 32
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB20m12; GenBank #AF349987

<400> 32

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca gct aat gtt gct gga tca tta ttt aag aaa tta     384
Ile Leu Ala Ala Ala Ala Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca     432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg     480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt     528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175
```

```
aat act gca agt cct gct gtg caa tca gcc tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ttg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 33
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 33

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95
```

```
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Ala Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 34
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB40m1; GenBank #AF349988

<400> 34

```
atg ggt aaa tta tta ctg ata ata ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Ile Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tat atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat aca gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

att atc gtc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205
```

```
tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 35
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 35

```
Met Gly Lys Leu Leu Leu Ile Ile Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125
```

```
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 36
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB40m5;p GenBank #AF349989

<400> 36

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30
```

```
tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
        115                 120                 125

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg      480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag aat cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Asn Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240
```

aat gtt gct gtt aaa gaa tct tct aat gct 750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 37
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 37

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145 150 155 160

```
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Asn Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 38
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB40m12; GenBank # AF34999

<400> 38

```
atg ggt aaa tta tta cgg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Arg Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
```

```
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc gtt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 39

<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 39

```
Met Gly Lys Leu Leu Arg Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190
```

```
Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 40
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB100m5; GenBank #AF349991

<400> 40

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca      48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt      96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc     144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act     192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg     240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac     288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
```

```
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 41
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 41

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15
```

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
180 185 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

```
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 42
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB100m7; GenBank #AF349992

<400> 42

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gct act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
```

```
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga att atg gca gct tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct      576
Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gct gct gtt aaa gaa tct tct aat gct                              750
Asn Ala Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 43
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 43

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45
```

```
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
            180                 185                 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Ala Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 44
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB100m9; GenBank #AF349993

<400> 44

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

ata gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gcc gct gca act aat gtt gct gga tca tta ttt aag aaa tta      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

ctt gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
```

```
145                 150                 155                 160

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat      576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac ctt atg ggt gac ggt gga tca gca ctt aac tta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 45
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 45

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                   10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80
```

```
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145                 150                 155                 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 46
<211> 750
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS
<222> (1)..(750)
<223> Proteorhodopsin variant from pcr clone MB100m10; GenBank #AF34999

<400> 46

```
atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt       96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

tct ttt tgg tta gtt aca gct gct cta tta gcg tct act gta ttt ttc      144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act      192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg      240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac      288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt      384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca      432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
    130                 135                 140

gga ata atg gcg gct tgg cct gca ttc atc gtt gga tgt tta gca tgg      480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Val Gly Cys Leu Ala Trp
145                 150                 155                 160

gta tat atg att tat gaa cta tgg gct ggt gaa gga aaa tct gca tgt      528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
                165                 170                 175

aat act gca agt cct gct gta cag tca gct tac aac aca atg atg tat      576
```

```
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
            180                 185                 190

atc atc atc gtt ggt tgg gca att tat cct gta ggt tat ttc aca ggt      624
Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
        195                 200                 205

tac cta atg ggt gac ggt gga tca gct ctt aat cta aac ctt att tat      672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
    210                 215                 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg      720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225                 230                 235                 240

aat gtt gct gtt aaa gaa tct tct aat gct                              750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 47
<211> 250
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 47

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1               5                  10                  15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
```

100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Val Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 48
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PALB1; GenBank #AF349995

<400> 48
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca 48

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg cta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt     384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct     432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att ctt ggt atg gct ggt tgg     480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Leu Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta     528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gct tac aat gca atg atg aag     576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt     624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata     672
```

```
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 49
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 49

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
```

```
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Leu Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 50
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PALB2; GenBank #AF349996

<400> 50

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
```

```
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct gag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Glu Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
```

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 51
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 51

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Glu Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val

165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 52
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PALB5; GenBank#AF349997

<400> 52
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt 96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt 144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act 192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

gta tct ggt tta att act ggt ata gcc ttt tgg cat tat ctc tat atg 240

```
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac cta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 53
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 53

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
```

195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 54
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PalB7; GenBank #AF349999

<400> 54
atg ggt aaa tta tta ctg ata tta ggt agt gct att gcg ctt cca tca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt 96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

tca ttc tgg ctg gtt acg gct ggt atg tta gcg gca act gta ttc ttt 144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act 192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg 240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat 288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta 336

```
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gcc gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca ttg gta atg tta ggt gct gga tct gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Ser Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctc ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 55
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 55

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
```

20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Ser Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile

225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 56
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PalB6; GenBank # AF349998

<400> 56

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca   48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt   96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt  144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act  192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg  240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat  288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta  336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt  384
Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125
```

```
cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac cta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 57
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 57

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45
```

```
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 58
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacteria

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PalB8; GenBank #AF350000

<400> 58

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160
```

```
tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ctt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 59
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacteria

<400> 59

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80
```

```
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 60
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacteria

<220>
<221> CDS
<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PalE1;GenBank# AF350001

<400> 60

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta tat atg ggt gaa ggc aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac cct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Pro Ala Tyr Asn Ala Met Met Met
            180                 185                 190
```

```
att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 61
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacteria

<400> 61

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
            100                 105                 110
```

```
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Pro Ala Tyr Asn Ala Met Met Met
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 62
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PalE6; GenBank#AF350002

<400> 62

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15
```

```
ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt      96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt     144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act     192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg     240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat     288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta     336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt     384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct     432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

ggt tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg     480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta     528
Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg aag     576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt     624
Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata     672
Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220
```

```
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 63
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 63

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140
```

```
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
            180                 185                 190

Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 64
<211> 753
<212> DNA
<213> Naturally occurring gamma proteobacterium

<220>
<221> CDS
<222> (1)..(753)
<223> Proteorhodopsin variant from pcr clone PalE7; GenBank# AF350003

<400> 64

```
atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca       48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                   10                  15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt       96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt      144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45
```

```
ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act      192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg      240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

aga ggt gtt tgg ata gat act ggt gat acc cca aca gta ttc aga tat      288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta      336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt      384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct      432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg      480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

cta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta      528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg      576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt      624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

tac cta atg ggt ggc gaa ggc gta tac gct tca aac tta aac ctt ata      672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att      720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct                          753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```

<210> 65
<211> 251
<212> PRT
<213> Naturally occurring gamma proteobacterium

<400> 65

```
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1               5                  10                  15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
            20                  25                  30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
        35                  40                  45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
    50                  55                  60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65                  70                  75                  80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
                85                  90                  95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
            100                 105                 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
        115                 120                 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
    130                 135                 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145                 150                 155                 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
                165                 170                 175
```

```
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
            180                 185                 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
        195                 200                 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
    210                 215                 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225                 230                 235                 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
                245                 250
```